#902

Instruction Manual

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JOHN FLUKE MFG. CO., INC.
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MODEL 931

RMS AC DIFFERENTIAL VOLTMETER

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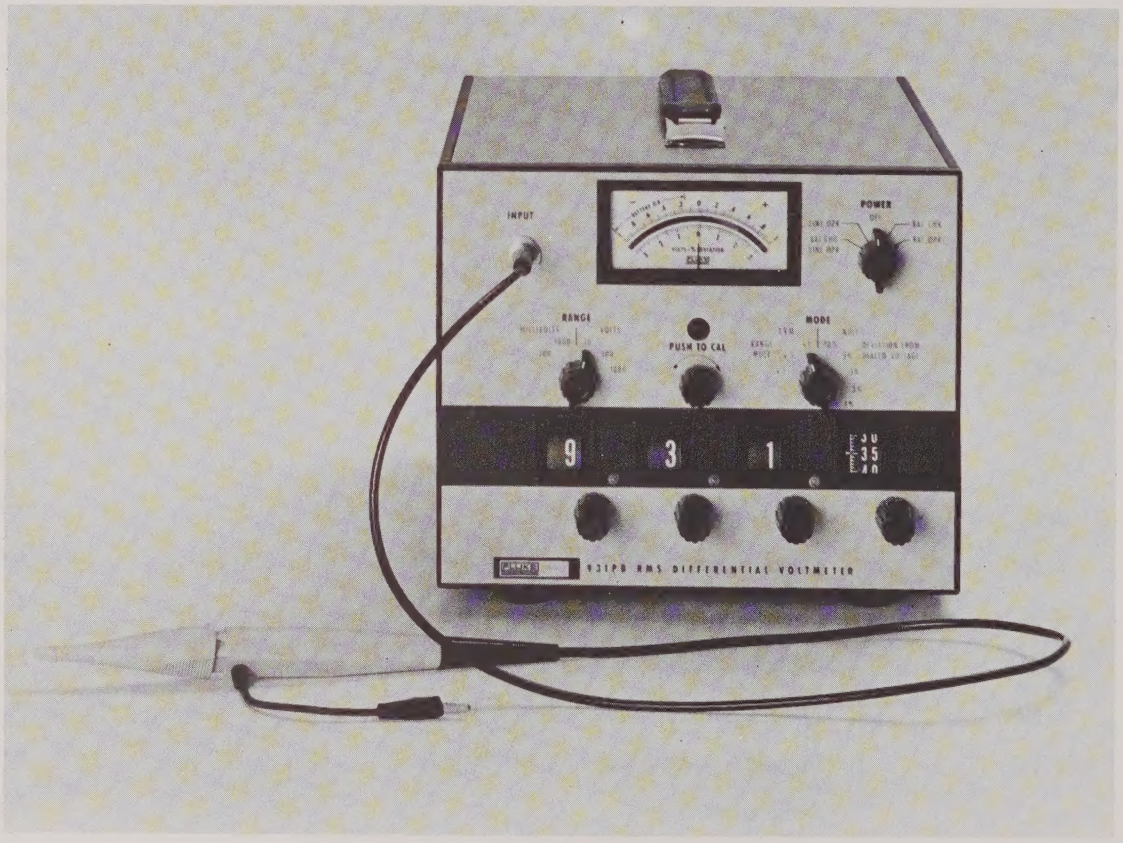


MODEL 931 RMS AC DIFFERENTIAL VOLTMETER

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. The Model 931 RMS AC Differential Voltmeter provides true rms measurement of ac voltages from 0.003 volts to 1100 volts. The instrument includes a BNC input connector version, consisting of the line powered Model 931A and the line-battery powered Model 931AB, and a permanently attached cable and probe version, line powered Model 931P and the line-battery powered Model 931PB. The instruments are half-rack, 19 inch standard, in size, and are equipped with resilient feet and tilt-up bail for field or bench use. A single instrument may be mounted in a standard 19 inch rack by means of metal handle rack adapter kit 881A-102. Two instruments may be mounted side-by-side in a standard 19 inch rack by means of metal handle rack adapter kit 881A-103.

1-3. Since the Model 931A is an rms-responding device instead of average or peak responding, it is suitable for measurement and calibration of square, triangular, and sawtooth waves without the need for corrections. The instrument measures the true rms value of the unknown, regardless of harmonic content or phase variation in the harmonics.

1-4. A linear recorder output enables the instrument to be used as an rms ac to dc converter, as well as for production testing. Deflection of the panel meter is in volts for operation as a conventional voltmeter, and is in percent of the dial setting for differential measurements. The deflection as a percent of dial setting aids in measuring deviation of the unknown from a nominal value.

1-5. ELECTRICAL SPECIFICATIONS

TVM MODE

INPUT VOLTAGE RANGE
0.003 to 1100v rms in eleven end scale ranges of 0.01 to 1000v in 1, 3 sequence, each with 10% overranging.

FREQUENCY RANGE
2 Hz to 2 MHz.

ACCURACY 0°C to 50°C
10 Hz to 500 kHz, ±3% of end scale.
2 Hz to 2 MHz, ±8% of end scale.

CREST FACTOR
10 at end scale increasing proportionately to 30 at 1/3 scale (1500v peak maximum).

DIFFERENTIAL MODE

INPUT VOLTAGE RANGE
0.01 to 1100v rms in five ranges of 0.1, 1, 10, 100, and 1000v rms, each with 10% overranging.

FREQUENCY RANGE
10 Hz to 1 MHz.

NULL RANGES (end scale percentage deviations from voltage dial setting.)

10%-0-10%	(0.2% per scale division)
3%-0-3%	(0.1% per scale division)
1%-0-1%	(0.2% per scale division)
0.3%-0-0.3%	(0.01% per scale division)
0.1%-0-0.1%	(0.002% per scale division)

ACCURACY (at 23°C ±1°C, nominal calibration temperature.)

30 Hz to 50 kHz
±(0.05% of input +0.005% of range) from 0.01 to 500v rms
30 Hz to 20 kHz
±0.1% of input from 500 to 1100v rms
20 kHz to 50 kHz
±0.15% of input from 500 to 1100v rms
10 Hz to 30 Hz
±0.2% of input from 0.01 to 1100v rms
50 kHz to 100 kHz
±0.2% of input from 0.01 to 1100v rms
100 kHz to 200 kHz
±0.5% of input from 0.01 to 1100v rms*
200 kHz to 500 kHz
±1% of input from 0.01 to 1100v rms*
500 kHz to 1 MHz
±3% of input from 0.01 to 1100v rms*

* Input voltage times frequency product should not exceed 1 x 10^8 volt-hertz.

TEMPERATURE COEFFICIENT OF ACCURACY
(0°C to 50°C)

±0.0025%/°C	10 Hz to 30 kHz
±0.004%/°C	30 kHz to 50 kHz
±0.01%/°C	50 kHz to 200 kHz
±0.03%/°C	200 kHz to 1 MHz

CREST FACTOR
10, or 1500v peak maximum.

GENERAL

INPUT IMPEDANCE
Models 931A and 931AB - 1 Megohm shunted by less than 8 pf at front panel BNC connector.

Models 931P and 931PB - 1 Megohm shunted by less than 7 pf at probe.

SHORT-TERM STABILITY
Better than 0.005% per hour and 0.02% per day without adjustment of front panel CAL control.

LONG-TERM STABILITY
Better than 0.01% per 30 days and 0.02% for 90 days, reset to zero during periodic calibration.

OVERLOAD PROTECTION
Transistor driver and relay protects instrument from damage by overloads up to 1500v peak or 1000v rms on any range and automatically resets upon removal of overload.

LINE REGULATION
Better than 0.0005% for a 10% line voltage change from nominal.

DC RECORDER OUTPUT
Linear, proportional to meter deflection. Either 1 vdc at end scale (1k output resistance), or adjustable from 0 to 1 vdc at end scale. Accuracy of output (0°C to 50°C):

10 Hz to 500 kHz	±1% of end scale
2 Hz to 2 MHz	±5% of end scale

INPUT POWER
Models 931A and 931P - 115/230 vac, 50 Hz to 440 Hz, 3 watts.

Models 931AB and 931PB - 115/230 vac, 50 Hz to 440 Hz plus 22 hours minimum operation from internal rechargeable nickle-cadmium batteries. (25 watts line power required during recharge while operating.)

1-6. ENVIRONMENTAL SPECIFICATIONS

OPERATING TEMPERATURE RANGE
0°C to 50°C.

STORAGE TEMPERATURE RANGE
Models 931A and 931P -40°C to +70°C.
Models 931AB and 931PB -40°C to +60°C.

SHOCK
Meets hammer-blow requirements of MIL-T-945A.

VIBRATION
Meets all requirements of MIL-T-945A.

1-7. MECHANICAL SPECIFICATIONS

SIZE
7" high x 8-1/2" wide x 11-3/4" deep. (19" wide in rack configurations.)

WEIGHT
Models 931A and 931P - 11-1/2 lbs.
Models 931AB and 931PB - 15 lbs.

MOUNTING
Resilient feet provide for bench and portable use. For side-by-side EIA rack mounting of two units, add Adapter Kit 881A-103 (includes handle-brackets and key plate). For EIA rack mounting of a single unit, add Adapter Kit 881A-102 (includes brackets with handles).

SECTION II

OPERATING INSTRUCTIONS

2-1. RECEIVING INSPECTION

2-2. This instrument has been thoroughly tested and inspected before being shipped from the factory. Immediately upon receiving the instrument, carefully inspect for damage which may have occurred during shipment. If any damage is noted, follow the instructions outlined in the warranty page at the back of this manual.

2-3. CONTROLS, TERMINALS, AND INDICATOR

2-4. The location and function of front and rear panel controls, terminals, and indicators are described in Figure 2-1. Detailed operating descriptions are given in following paragraphs.

2-5. PRELIMINARY OPERATION OF MODELS 931A AND 931P

2-6. Connect the power plug to a 115 volt ac power source, or to 230 volts ac if the instrument is so wired. Place the Model 931 controls as follows:

POWER	ON
RANGE	1000
MODE	TVM X1
Readout Dials	10-0-0-000

WARNING!

The round pin on the polarized three-prong plug connects the instrument case to power system ground. Use a three-to-two pin adapter when connecting to a two-contact outlet. For personnel safety, connect the short lead from the adapter to a high-quality ground.

2-7. PRELIMINARY OPERATION OF MODELS 931AB AND 931PB

2-8. For line operation, connect the power plug to a 115 volt ac power source, or to 230 volts ac if the instrument is so wired.

WARNING!

The round pin on the polarized three-prong plug connects the instrument case to power system ground. Use a three-to-two pin adapter when connecting to a two-contact outlet. For personnel safety, connect the short lead from the adapter to a high-quality ground.

2-9. For battery operation, set the POWER switch to BAT CHECK, and wait 10 seconds. The meter should deflect within the BATTERY OK region. If the batteries indicate fully discharged, charge the batteries as outlined in paragraph 2-11. If the batteries are adequately charged, set the POWER switch to BAT OPR.

2-10. Place the Model 931 controls as follows:

RANGE	1000
MODE	TVM X1
Readout Dials	10-0-0-00

2-11. BATTERY CHARGING OF MODELS 931AB AND 931PB

2-12. Connect the power plug to a 115 volt ac power source, or to 230 volts ac if the instrument is so wired.

2-13. Set the POWER switch to BAT CHG-LINE OPR. After 16 hours, batteries will be fully charged, and capable of operating the instrument for at least 22 hours. Measurements may be made with the instrument while the batteries are being charged.

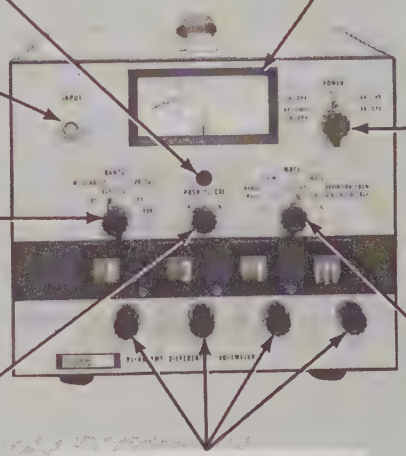
METER
In the NULL mode of operation, the meter is a null indicator. Scale calibration of 1-0-1 or 3-0-3 is determined by the MODE switch percent DEVIATION FROM DIALED VOLTAGE position. During the TVM Mode of operation, the meter functions as a conventional voltmeter with the +1 or +3 scale determined by the MODE switch RANGE MULT selected.

MECHANICAL ZERO
Screwdriver adjustment to set the motor to zero.

INPUT
Provides connection to voltage being measured.

POWER SWITCH
OFF position power removed from Model 931. LINE OPR position Model 931 operates on line power. BAT CHG LINE OPR position Model 931 operates on line power while charging batteries. BAT CHK position indicates relative charge of batteries on meter. BAT OPR position Model 931 operates on internal battery supply.

RANGE SWITCH
Selects one of five voltage ranges available and positions the decimal point for the readout dials.

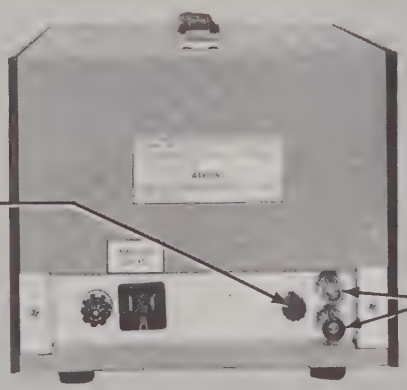


PUSH TO CAL CONTROL
Push and rotate control used to compensate for ambient temperature changes and long term drift. PUSH TO CAL control is used to set for meter zero prior to use on NULL mode.

MODE SWITCH
TVM Mode - Selection of one of three range multipliers available for on-scale meter deflection. NULL Mode - Selection of one of five percent of deviation of dialed voltage positions available. Meter resolution of 20 ppm of input per small divisions available on the .1% NULL range.

READOUT DIALS
During NULL mode of operation these controls are adjusted to achieve meter zero (null). The READOUT DIALS indicate the magnitude of the input voltage.

CALIBRATED OUTPUT CONTROL
For full scale meter deflection, this control provides adjustment of the RECORDER OUTPUT voltage from 0 to 1 volt. A switch at the clockwise extremity of movement provides a calibrated 1 volt output when the input signal is equal to full scale deflection.



RECORDER OUTPUT TERMINALS
Provides up to one volt output for external recorder.

Figure 2-1. MODEL 931 FRONT AND REAR PANEL CONTROLS

CAUTION!

Since overcharging decreases battery life, it is recommended that the batteries be charged for less than 48 hours, and never more than 1 week. When used properly, the batteries will provide more than 200 charge-discharge cycles. To provide maximum charge-discharge cycles use the instrument until the batteries indicate fully discharged before recharging the batteries.

2-14. CALIBRATION FOR NULL MODE OPERATION

2-15. A front-panel PUSH TO CAL control is provided to compensate for changes due primarily to variation in ambient temperature. The PUSH TO CAL control can be adjusted for a null without regard to the position of other front panel controls. Periodic adjustment of the PUSH TO CAL control will probably be necessary during operation of the instrument in the NULL mode. Proceed as follows:

a. If necessary, mechanically zero the meter with the adjustment screw on the front panel. All power must be removed from the instrument for at least three minutes prior to this adjustment.

b. Set the POWER switch to ON, or to LINE OPR with the battery models, and allow 1 minute for the instrument to warmup.

c. Press the PUSH TO CAL knob, and rotate as necessary for zero meter deflection.

2-16. OPERATION AS A CONVENTIONAL RMS VOLTMETER

2-17. To operate the Model 931 as a conventional voltmeter proceed as follows:

a. Perform preliminary operation according to paragraph 2-5 or 2-7.

b. Set the RANGE switch to the desired voltage range. If the approximate value of voltage is unknown, select the 1000 volt range initially.

c. Connect the voltage to be measured to the INPUT connector, or to the probe, according to the model being used.

d. If necessary, reduce the voltage range selected by the RANGE switch until deflection of the meter occurs. The rms value of the voltage being measured will be indicated by the meter. When measuring in the TVM mode, the meter will always deflect to the right.

e. Because of the inaccuracy of measurements of less than 1/3 of full scale, use the X. 3 or X. 1 RANGE MULT positions of the MODE switch to expand meter deflections which would otherwise be less than 1/3 of full scale.

2-18. OPERATION AS A DIFFERENTIAL RMS VOLTMETER

2-19. To operate the Model 931 as a differential voltmeter proceed as follows:

a. Perform preliminary operation according to paragraph 2-5 or 2-7.

b. Connect the voltage to be measured to the INPUT connector, or to the probe, according to the input being used.

c. With the instrument in the TVM mode, set the RANGE switch to the lowest range possible while retaining on-scale meter deflection, and note the voltage indicated. The X. 3 or X. 1 RANGE MULT positions of the MODE switch may be used if necessary.

d. Set the four readout dials to the voltage determined in step c. For example, if the voltage is approximately 35 volts, the decimal point will be between the second and third readout dials. Therefore set the first dial to 3 and the second dial to 5.

e. Set the MODE switch from TVM to NULL 10%, and adjust the readout dials for zero meter deflection. Meter deflection to the right indicates that the voltage being measured is greater than the voltage set on the readout dials. Deflection to the left indicates the voltage is less than the readout dial setting.

f. Set the MODE switch to successively more sensitive null ranges, and adjust the readout dials for zero meter deflection in each range. Note that the meter deflection in the NULL MODE is in terms of a percent of the input voltage. Meter resolution for the .1% NULL range is 20 ppm of input per small division.

g. Voltages smaller than 1/10 of full scale are not normally measured on a given range, since a lower range should be selected. For voltages smaller than 10 millivolts, measurements are made with reduced accuracy.

2-20. MEASUREMENT OF A VOLTAGE EXCURSION ABOUT A NOMINAL

2-21. To measure voltage excursions about a nominal value proceed as follows:

a. Perform preliminary operation according to paragraph 2-5 or 2-7.

b. Connect the voltage to be monitored to the INPUT connector, or to the probe, according to the input being used.

c. Set the RANGE switch to the lowest range possible while retaining on-scale meter deflection, and note the voltage indicated. The X. 3 or X. 1 RANGE MULT positions of the MODE switch may be used if necessary.

d. Set the four readout dials to the voltage determined in step c. For example, if the voltage is approximately 35 volts, the decimal point will be between the second and third readout dials. Therefore, set the first dial to 3, and set the second dial to 5.

e. Set the MODE switch from TVM to NULL 10%, and adjust the readout dials for zero nominal meter deflection.

f. Set the MODE switch to the most sensitive NULL range possible, keeping the voltage excursions on-scale.

g. Voltage excursions, in percent of dial setting, are indicated by meter deflection.

2-22. USE OF RECORDER OUTPUT

2-23. A recorder may be used with the voltmeter to record meter deflection. The RECORDER OUTPUT voltage is adjustable up to 1 volt for full-scale meter deflection. Since the low side of the recorder output is grounded, the input isolation characteristic of the recorder is of no consequence. Proceed as follows:

a. Connect the RECORDER OUTPUT terminals on the back panel of the Model 931 to the input terminals of the recorder.

b. Perform the preliminary operation according to paragraph 2-5 or 2-7.

c. Apply an ac voltage to the Model 931 so that the meter indicates exactly full scale (+1 or +3.16) in the TVM mode.

d. Adjust the RECORDER ADJ control until recorder deflection is as desired for full-scale meter deflection. A switch is included in the clockwise end of the RECORDER ADJ control, which will provide a calibrated 1 volt output when the input signal is equal to full-scale of the range being used.

e. Connect the voltage to be monitored to the INPUT connector, or to the probe, according to the model being used.

f. The voltmeter and recorder are ready for use. Proceed according to paragraph 2-20. Note that if the instrument is used in the NULL mode, with the readout dials set to a nominal voltage, the recorder output is proportional to excursions of the voltage being monitored. However, if the instrument is used in the TVM mode, recorder output is still proportional to meter deflection, and the instrument is functioning as a true-rms ac-to-dc converter.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. The Model 931A RMS AC Differential Voltmeter block diagram is illustrated by Figure 3-1. A functional schematic diagram is located at the end of Section V. The block diagram and functional schematic diagrams are intended as an aid in understanding circuit theory and in troubleshooting the instrument.

3-3. BLOCK DIAGRAM ANALYSIS

3-4. The Model 931 consists of an input amplifier, variable gain ac amplifier, null detector, meter, and calibration circuits. A block diagram analysis of the Model 931 is outlined in paragraphs 3-5 through 3-24.

3-5. TVM MODE

3-6. The input signal is amplified by the input amplifier which is an operational type amplifier. The gain of the amplifier is proportional to the ratio of feedback impedance to input impedance and is adjusted during calibration to be a precise multiple of the input impedance. There are five ranges available, each having individual compensating adjustments, selected by the RANGE switch.

3-7. The variable gain ac amplifier amplifies the output of the input amplifier and is an operational type amplifier. The gain of the amplifier is proportional to the ratio of feedback impedance to input impedance. Feedback impedance is selected by the MODE switch and is one of three fixed precise multiples of the input impedance. The input and feedback components are not compensated, as they are wirewound devices of low value with low shunt capacities. The output signal then is applied to the thermocouple TC1 heater element.

3-8. Thermocouple TC1 generates a dc output signal proportional to the true rms ac heating value of the current through its resistive heating element, regardless of the waveform shape. The output of TC1 is applied to the null detector.

3-9. The null detector amplifies the output of TC1 and applies its output current to the heater element of thermocouple TC2 via R_S.

3-10. TC2 heater element current flow generates a dc voltage opposing the output voltage generated by TC1. This completes a feedback loop which produces a dc current through the TC2 heater proportional to the rms value of the ac current through the TC1 heater.

3-11. The meter amplifier senses the voltage drop across R_S and the heater of TC2, amplifies the signal, and drives the meter and recorder output circuit.

3-12. NULL MODE

3-13. The input amplifier operates the same as in the TVM mode and amplifies the input signal with a gain inversely proportional to the range selected by the RANGE control. The output signal is then applied to the variable gain ac amplifier.

3-14. Variable gain ac amplifier amplifies the input signal with a gain inversely proportional to the differential dial switch settings on the null mode. The output signal of the variable gain amplifier passes through the heater element of thermocouple TC1.

3-15. Thermocouple TC1 generates a dc output signal, as in the TVM mode, which is applied to the null detector.

3-16. The null detector amplifies the output of TC1, as in the TVM mode, and applies its output to the heater element of TC2 via R_S.

3-17. Thermocouple TC2 heater element receives a reference current via the mode switch on differential mode which allows the null detector to only add or subtract a small current until the outputs of the two thermocouples are equal and opposing. The differential dials are then adjusted until the output of TC1 matches the reference output of TC2.

3-18. The meter amplifier senses any increase or decrease in voltage drop across R_S and the heater of TC2, amplifies the signal, and drives the meter and recorder output circuit.

3-19. CALIBRATION MODE

3-20. When the front panel PUSH TO CAL control is depressed, the overload calibrate relay is energized which applies a calibration current to the heater element of TC1 from the reference zener.

3-21. The thermocouple TC2 heater element receives a variable current via the PUSH TO CAL control in the calibration mode.

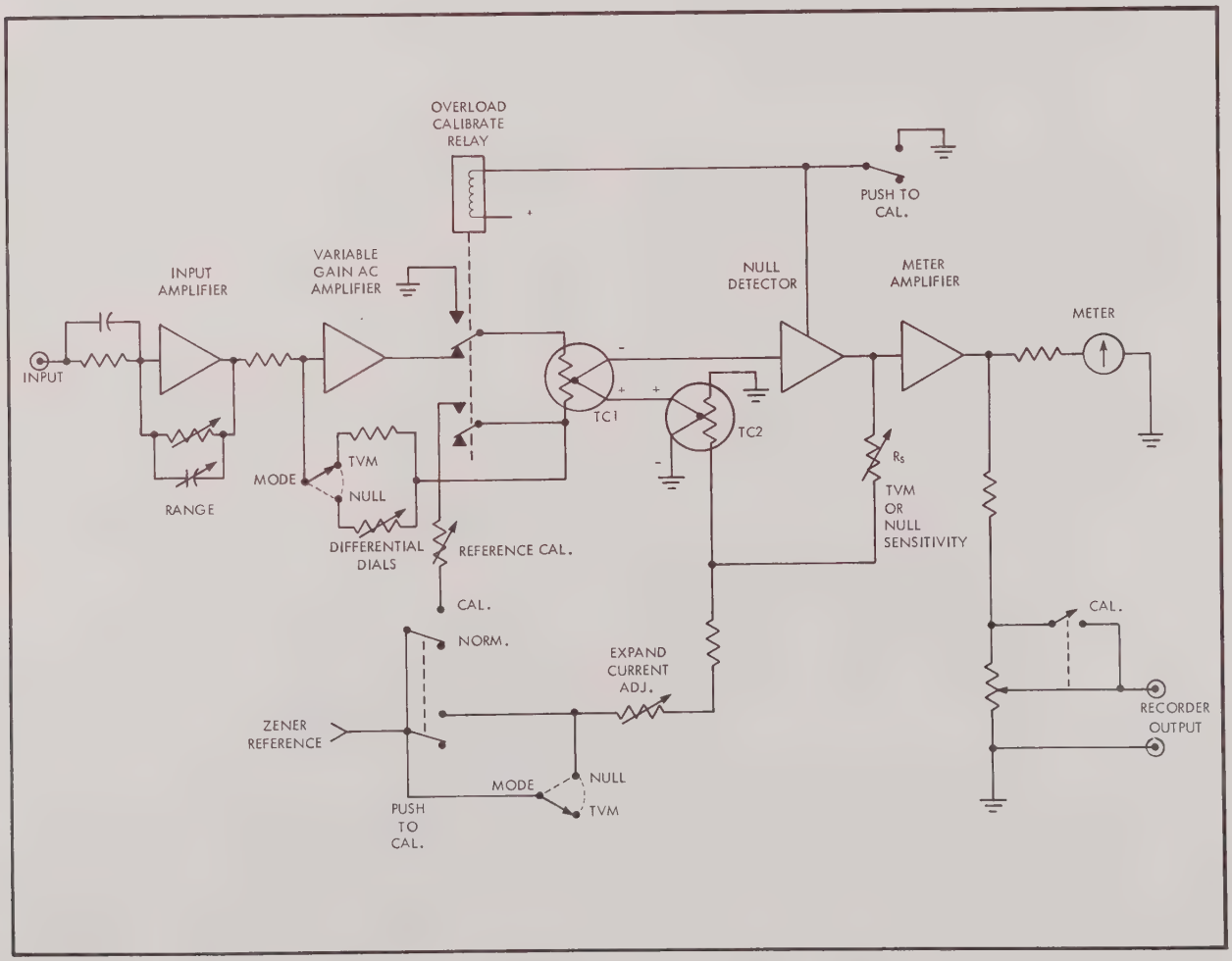


Figure 3-1. THE MODEL 931 FUNCTIONAL BLOCK DIAGRAM

3-22. The null detector amplifier and meter amplifier amplifies any difference signal at the output of the thermocouples and displays it on the meter.

3-23. The EXPAND CURRENT ADJUST control then adjusts the current through TC2 until a null is obtained on the meter. The instrument is now calibrated. When a null in the null mode is obtained, the input voltage will produce an ac current through the TC1 heater element which will exactly equal the rms value of the reference calibrate current.

3-24. REGULATED POWER SUPPLIES

3-25. The Model 931 regulated power supplies provide +14.5 volts dc and -14.5 volts dc for use throughout the instrument. The +14.5 volts dc regulator provides the input voltage for the zener reference supply. Line regulation of the Model 931 is better than 0.0005% for a 10% line voltage change. The output voltage of the regulated power supplies is adjusted by R143, adjustment L.

3-26. INPUT POWER

3-27. Input power transformer T1, receives 115 volts ac (or 230 volts ac if so wired) at 50 to 440 Hz. The primary winding of T1 is constructed in such a manner as to utilize either 115 volts ac input, windings parallel, or 230 volts ac input, windings in series. Fuse F1 protects the Model 931 circuits from overloads.

3-28. The secondary voltage of T1 is half-wave rectified by CR104 and CR105. The positive half-wave rectifier, CR104, output voltage of +22 volts dc is filtered by C122, R132, and C123 before being applied to the positive regulator. The negative half-wave rectifier, CR105, output voltage of -22 volts dc is filtered by C124, R133, and C125 before being applied to the negative regulator.

3-29. BATTERY OPERATED MODELS INPUT POWER

3-30. In the Model 931AB and 931PB, input power to the series regulators is supplied by BT1 and BT2 when the POWER switch, S1 (E and D), is placed to BAT OPR position.

3-31. When the POWER switch is placed to BAT CHG LINE OPR position, 28 volts ac from the secondary of T1 is applied via S1C, to the half-wave rectifiers, CR201 and CR202. Resistors R8 and R9 are voltage dropping resistors. Fuses, F2 and F3, protect the battery circuit.

3-32. An indication of relative battery charge is available on the Model 931 meter when the POWER switch is placed to BAT CHK position. The meter is placed between BT1 and the +14.5 volts dc regulator by POWER switch S1 (F and G). Resistor R39 is a meter multiplier. The meter indicates the relative charge of BT1.

3-33. POSITIVE 14.5 VOLTS DC REGULATOR

3-34. The input voltage supplied to series pass transistor Q109 is reduced to +14.5 volts dc and regulated in the following manner. A voltage proportional to the output voltage is developed at the base of differential amplifier Q114 by voltage divider R142, R143, and R144. At the other input amplifier base, Q115, zener diode CR106 establishes a reference voltage. Output voltage variations with respect to the reference voltage are amplified and appear as an error signal at the collectors of Q114 and Q115. The error signal is then amplified by differential amplifier Q111 and Q112. The output from Q111 controls the series pass transistor Q109. The voltage drop across Q109 is therefore controlled by the differential amplifier to maintain a constant +14.5 volts dc output. Transistor Q106 is in the circuit to insure that Q109 will initially conduct. Once Q109 conducts, Q106 will be reversed biased. The constant +14.5 volts dc is connected to one end of resistor R150. The other end of the resistor is connected to the constant voltage developed by CR106. Because the resistor, R150, is connected between two constant voltage points, the current thru it is constant. The value of R150 is factory selected for optimum current through CR106, therefore establishing a constant reference voltage.

3-35. NEGATIVE 14.5 VOLTS DC REGULATOR

3-36. The input voltage applied to series pass transistor Q108 is reduced to -14.5 volts dc and regulated in the following manner. A voltage proportional to the output voltage is developed at the base of amplifier Q110 by voltage divider R141 and R140. Output voltage variations are amplified by Q110 and appear as an error signal at the base of Q107. The error signal is then amplified by Q107. The output of Q107 controls the series pass transistor Q108. The voltage across Q108 is therefore controlled by the amplifier to maintain a constant -14.5 volts dc output. Transistor Q113 is in the circuit to insure that Q108 will initially conduct.

3-37. INPUT AMPLIFIER

3-38. The input amplifier is composed of five stages of direct coupled ac amplifiers forming an operational amplifier. Negative feedback networks are adjusted to be a precise multiple of the fixed input RC network, with the gain being a predictable inverse function of the RANGE selected.

3-39. The input circuit of the input amplifier is composed of R1 and C1, which exibit an input impedance to the instrument of 1 megohm shunted by less than 8 pf. By placing the input RC network in the probe on the probe versions, the probe cable capacity is effectively eliminated. The input terminals are then effectively extended the 36 inch probe cable length. The first input amplifier, Q101, is a field effect transistor which is utilized for its high input impedance, high gain, and low noise features. The next three stages, Q102 thru Q104, are direct coupled ac amplifiers. The output of Q104 is fedback to the input of Q103 with a phase difference of 180° producing internal negative feedback. With the RANGE switch to the 100 MV position, the feedback impedance is at maximum and amplifier gain is maximum. On the 1000 millivolt RANGE switch position, C106, R113, and C111 are added to the internal feedback circuit decreasing its impedance and the amplifier gain. On the 10, 100, and 1000v RANGE switch positions, R113 and C111 are bypassed by the switch contacts of

S101D which further decreases the feedback circuit impedance and the amplifier gain. Capacitor C108 is for high frequency compensation of the feedback network, and is adjusted at 5 MHz. The final stage of the input amplifier consists of emitter follower Q105 which is used to provide a low output impedance. The output of Q105 is fed back to the input of the input amplifier via the RANGE switch with a phase difference of 180° producing overall negative feedback. The feedback network impedance selected by the RANGE switch is inversely proportional to the voltage range selected. Consequently, amplifier gain is inversely proportional to the RANGE switch setting. Compensating adjustments are available in each feedback network to enable precise adjustment of the input amplifier gain. The output signal applied to the variable gain ac amplifier is attenuated by a factor of 10 on the 1000v RANGE switch position, S101F, by the resistive network of R119 and R122.

3-40. VARIABLE GAIN AC AMPLIFIER

3-41. The variable gain ac amplifier is composed of five stages of amplification, forming an operational amplifier. Negative feedback is one of three fixed values on the TVM mode, and a variable value on the NULL mode. The gain of the amplifier is inversely proportional to the selected TVM range or differential dial settings.

3-42. The first four stages of the variable gain ac amplifier consists of Q201, Q202, Q203, and Q204. High frequency compensation is provided for by internal negative feedback from the collector of Q203 to the base of Q202. Low frequency compensation is provided by feedback from the emitter of Q204 to the emitter of Q201. The output of Q204 drives the complementary push-pull amplifier stage consisting of Q206 and Q207. Transistor Q205 establishes the bias level of the complementary push-pull amplifier. The output of the push-pull amplifier is applied to the heater of TC1 which produces a dc voltage proportional to the rms value of the ac heater signal. The output signal of the push-pull amplifier is also fed back to the input of the variable gain ac amplifier via the MODE switch with a phase difference of 180° to the input. During the TVM mode of operation a range resistor of proper value is selected by the MODE switch. The value of impedance in the feedback circuit is reduced by a factor of ten as the MODE switch progresses from X.1 through X1. This reduction of impedance in the feedback circuit causes a corresponding decrease in amplifier gain. During the NULL mode of operation the Readout Dials select the feedback impedance. As the Readout Dials settings are numerically increased, the impedance of the feedback circuit is decreased, which causes a proportional decrease in gain of the variable gain ac amplifier. The R/C network in parallel with the heater of TC201 is a high frequency compensating network. Compensation at 20 kHz is accomplished by C218 and R233. Compensation at 500 kHz is accomplished by C219 and R234.

3-43. THERMOCOUPLES

3-44. Two high vacuum thermocouples, TC201 and TC202, are utilized in the Model 931. The outputs of the thermocouples are connected series opposing. TC201 heater element is ac operated while the heater element of TC202 is dc operated. The output of TC201 is a dc voltage proportional to the rms value of the ac heater current regardless of the waveform.

3-45. TVM MODE

3-46. During the TVM mode of operation the dc output of TC201 is amplified by the null detector. The output voltage of the null detector produces a dc current flow through the heater element of TC202. The dc current flow is proportional to the rms value of the ac current flow through the heater of TC201. This dc current flow through the heater of TC202 generates a voltage opposing the output of TC201. When TC202 output equals TC201 output, the null detector output is at the proper level and the true rms voltage is indicated by the readout circuits.

3-47. NULL MODE

3-48. For the NULL mode of operation, TC202 heater is connected in series with the resistive network of, R241 through R245 and R7, via the MODE switch S2A, to the zener reference voltage. The current flow through the heater of TC202 is approximately 2 ma. The output of the variable gain ac amplifier is then increased or decreased, as outlined in paragraph 3-42, until the current flow through the heater of TC201 matches the current through the heater of TC202. The output of the null detector adds or subtracts slightly from the reference current thru TC202 to indicate deviations from the null condition.

3-49. CALIBRATION

3-50. For calibration of the Model 931 the PUSH TO CAL switch, S3, contacts are closed. Relay K201 is energized which places the heater element of TC201 in series with a resistive network of R235 through R240 between the zener reference and ground. The zener reference causes a calibrated current to flow through TC201. The heater element of TC202 is connected to the zener reference during calibration by the contacts of S3C. The PUSH TO CAL control, R7, is engaged with the contacts of S3 closed, and R7 is adjusted until the output voltage of TC202 matches the output voltage of TC201.

3-51. NULL DETECTOR

3-52. The null detector is composed of a magnetic modulator, a push-pull oscillator and doubler, a carrier amplifier, a demodulator, an overload protection, and a meter amplifier. The null detector modulates, demodulates, and amplifies the dc output signal of TC201.

3-53. PUSH-PULL OSCILLATOR AND FREQUENCY DOUBLER

3-54. The push-pull oscillator and frequency doubler generates a 2.5 kHz sine wave to drive the magnetic modulator and a 5 kHz driving signal for the synchronous demodulator. The tuned-collector oscillator, Q301 and Q302 is tuned by the variable inductance of transformer T301 and fixed capacitor C301. The output signal is

induced in the output winding of T301 and applied to the magnetic modulator. The output signal is applied to the base of Q303 whose output current is used to control the oscillator output. The bases of Q301 and Q302 are biased by the collector voltage of Q303. As the output of the oscillator tends to increase, the feedback voltage to the base of Q303 increases. Q303 conducts harder reducing its collector voltage and decreases the forward bias of the bases of Q301 and Q302. This decrease in forward bias decreases the output level of the oscillator and maintains a constant output signal to T320. The emitter current of Q301 and Q302 is developed across R313. Because the transistors are connected in push-pull, there are two pulses for each cycle of the oscillator output which produces a 5 kHz signal. This signal is amplified by Q308 and is used to drive the synchronous demodulator.

3-55. MAGNETIC MODULATOR

3-56. The magnetic modulator is a multiple-winding second-harmonic magnetic modulator. The principle of operation is based upon the symmetrical saturation of the transformer core. During no-signal conditions the magnetic modulator is saturated symmetrically by the 2.5 kHz driving signal. Induced current flow of the second harmonic frequency, 5 kHz, in the third winding is at a minimum. DC input current in the input winding unbalances the symmetrical saturation pattern, resulting in the generation of the second harmonic of the driving signal. The amplitude is proportional to the magnitude of the dc input current. The phasing of the second-harmonic 5 kHz signal, with respect to the 2.5 kHz signal, is dependent upon the direction of current flow in the input winding. Meter dampening upon removal of an input signal during TVM Mode is accomplished by the magnetic modulator winding associated with Q304 and its circuitry. Feedback control of the magnetic modulator is controlled by the winding associated with Q319 and Q320 circuitry.

3-57. 5 KHZ TUNED CARRIER AMPLIFIER

3-58. The 5 kHz tuned carrier amplifier amplifies the 5 kHz output of the magnetic modulator. The transformer T303 is tuned to 5 kHz and rejects all other frequencies but the desired 5 kHz signal. Transistors Q305, Q306, and Q307 amplify the 5 kHz signal. Emitter feedback between Q307 and Q305 is utilized to prevent excessive loading of the input circuit. A tuned, series resonate circuit, L301 and C306, in the emitter circuit of Q305, provides frequency-sensitive negative feedback from the emitter of Q307. At frequencies other than 5 kHz the tuned circuit presents a high impedance to the feedback voltage, resulting in maximum negative feedback. At resonance, the tuned circuit impedance is at minimum, resulting in minimum feedback and maximum gain.

3-59. SYNCHRONOUS DEMODULATOR

3-60. The 5 kHz carrier signal contains null detector dc input voltage and polarity information which must be detected before being amplified by the dc amplifier. The synchronous demodulator operates as a conventional synchronized phase detector with the reference 5 kHz driving signal applied to its base circuit having a phase proportional to the magnetic modulator 2.5 kHz input signal. The detected dc voltage is developed across the load resistor R324, and is filtered by R325 and C313 before being amplified by the dc amplifier. Transient input signals to the null detector are suppressed by the feedback provided by C312.

3-61. DC AMPLIFIER

3-62. The dc amplifier is composed of a differential input amplifier consisting of Q310 and Q311, and dc amplifiers Q312 and Q313. Differential pair Q310 and Q311 amplify the input signal at the base of Q310 with respect to ground and applies its output to Q312 base circuit. Amplifiers Q312 and Q313 are direct coupled dc amplifiers. Transistor Q314 is used to provide a high-impedance current drive for the output circuit. During operation of the TVM mode, the output is developed across an output circuit comprised of CR1 and R10, paralleled by transistor-zener Q319, with R355, R356, and the thermocouple TC202 in series. The output signal is developed at the junction of R10 and zener Q319 for amplification by the meter amplifier. For operation on the NULL mode the MODE switch contacts of S2C bypass CR1. S2B selects the desired shunt resistor, R350 through R353. The output signal is now developed across the selected shunt resistor for amplification by the meter amplifier. As the MODE switch is placed from 10% to .1% positions, the shunt impedance is increased providing an increase in the meter amplifier input voltage. The meter then indicates that the ac current flow through the heater element of TC201 is within the prescribed percent selected by the MODE switch.

3-63. OVERLOAD DRIVE

3-64. The overload drive circuit composed of CR303, Q315, Q316 and K201, is used to prevent a shift of the thermocouple characteristics due to a current overload. Signal inputs of 1500 volts peak on any range will not damage the instrument.

3-65. When the output level voltage at the collectors of Q313 and Q314 reaches approximately 8 to 10 volts, the diode CR303 will conduct. Transistor Q315 is then forward biased, increasing its collector voltage. The increase in collector voltage of Q315 biases Q316 into conduction. Transistor Q316 conducts through the solenoid of relay K201 energizing the relay. With relay K201 energized, the input signal to the heater of TC201 is removed which causes the output of Q313 and Q314 to decrease. This decrease in output causes the relay K201 to de-energize, re-applying the ac signal to the heater of TC201. If an overload condition exists, the overload relay K201 will continuously energize and de-energize, protecting the thermocouples as long as the overload persists.

3-66. METER AMPLIFIER

3-67. The meter amplifier consists of a differential pair and two direct coupled dc amplifiers. Its output voltage drives the meter and recorder output circuits.

3-68. The output signal of the dc amplifier is amplified by the differential amplifier Q317 and Q318 with negative feedback from the output of the meter amplifier being applied to the base of Q318. The operating bias level of transistor Q318 is dependent upon the condition of MODE switch, S2D, contacts. During the NULL mode, the voltage at the base of Q318 is increased, increasing its operating range. Transistors Q321 and Q322 are direct coupled dc amplifiers whose output voltage drives the meter and recorder output circuits.

3-70. RECORDER OUTPUT

3-71. The recorder output circuit enables the use of the Model 931 as an rms ac to dc converter as well as for production testing.

3-72. The recorder output is developed across a divider network composed of R361, R362, R363, and R38. Resistor R38 is in use only during variable operation. With the recorder output adjust to the CAL position the output voltage is proportional to the meter deflection with 1 vdc representing full scale deflection. With the recorder output adjust to the variable position, switch S7 selects R38 allowing adjustment of the recorder output voltage.

SECTION IV

MAINTENANCE

4-1. GENERAL

4-2. The Model 931A RMS AC Differential Voltmeter series instruments should be checked for calibration every 90 days. Without extreme abuse all that should be required is periodic cleaning and calibration as specified in this section. To determine if the instrument is within specifications, it is recommended that the instruments performance be checked against the performance tests listed in this section. If a problem arises, please consult the information on corrective maintenance in this section.

4-3. TEST EQUIPMENT

4-4. Figure 4-1 lists the recommended equipment and specifications required for performance testing, calibration, and corrective maintenance. If the recommended equipment is not available, other equipment meeting the required specifications may be used.

4-5. BATTERY REPLACEMENT

4-6. Batteries in the Model 931AB and 931PB need to be changed when 48 hours of charging will no longer bring the meter to the minimum, nearest to meter zero, BATTERY OK region.

Note!

Zero deflection of meter during battery check and abrupt failure of unit during use in battery operate position may be caused by failure of battery fuses.

a. Invert the unit and remove the lower dust cover's four screws and remove the dust cover.

b. Remove the five screws that secure the plastic battery cover and lift the cover from the battery pack.

c. Unsolder the connecting wires from the twenty-six nickle-cadmium cells and discard the cells.

WARNING!

Nickle-cadmium cells, when heated or discharged rapidly, may give off hydrogen gas. Use care when disposing of this type of battery.

d. Install twenty-six 1.2v nickle-cadmium cells and solder the jumper wires in place. See Figure 4-2 for polarity and connections.

e. Replace the plastic battery cover and secure it with the five screws.

f. Replace the lower dust cover and secure it with the four screws.

g. Check batteries (paragraph 2-7). If the batteries show only a partial charge, use the instrument until the batteries are fully discharged, (as indicated by the battery check) before recharging. This procedure will prolong battery life.

EQUIPMENT	SPECIFICATIONS	RECOMMENDED INSTRUMENT
H F Oscillator	Frequency range of 500 Hz to 5 MHz. Short term stability of ±50 ppm/min.	Hewlett Packard Model 651A
Amplifier	Frequency range of 500 Hz to 800 kHz. Gain stability of ±50 ppm/min.	PA-250 AB Krohn-Hite Model DCA-10
Thermal Transfer Standard	AC to dc transfer accuracy of ±0.01%, 500 Hz to 50 kHz, at voltages of 1 volt to 100 volts.	Fluke Model 540B with test report.
DC Voltage Calibrator	Calibration accuracy of ±0.003%.	Fluke Model 332A
DC Differential Voltmeter	DC accuracy of ±0.2% (±0.005%) if the 332A is not used.	Fluke Model 871A
50 Ohm Load	Resistive load.	Tektronix 011-0049-00
Ratio Transformer AC	Accuracy of ±(1 + .25/ratio) ppm at 500 Hz.	Optimation Gertsch Model 1011R
Voltage Divider	Minimum reactance at 5 MHz.	1.82k ±1%, 1/2w 205 ohms ±1%, 1/2w Metal film resistors 0.5 pf Capacitor
True RMS Voltmeter	Frequency range of 10 Hz to 7 MHz with an accuracy of ±1% of full scale at 800 kHz.	Fluke Model 910
Oscilloscope	Sweep range: 50 usec/cm to 1 msec/cm. Sensitivity: 50 mv/cm	Tektronix Type 504
Frequency Counter	Must be able to measure 2.5 kHz with an accuracy of 0.1% ± count.	Hewlett Packard Model 521
Autotransformer	0-135 volts ac 3 amp	General Radio Model No. W5MT
AC Ammeter	0-500 ma	Simpson Model 157

Figure 4-1. TEST EQUIPMENT REQUIREMENTS

4-7. 230 VOLT POWER-LINE CONNECTIONS

4-8. All models of the 931 series may be converted for operation on 230 volts ac lines by modifying the input power transformer wiring as shown by the decal installed on the power transformer. Factory modified versions will have a decal on the rear panel.

a. Remove the top dust cover of the Model 931 to be converted by removing the six screws securing the cover to the chassis.

b. Locate T1 on the upper rear chassis. Remove the jumper between terminals 1 to 2, and 3 to 4. (See pin assignment decal on the transformer.)

c. Connect a jumper between terminals 2 to 3 and reinstall the dust cover.

d. Remove fuse (F1) and install a Type 3AG 1/8 amp fuse.

4-9. CORRECTIVE MAINTENANCE

4-10. GENERAL

4-11. If the Model 931 does not perform correctly before, during, or after calibration, the information contained here may be used to locate and correct the source of trouble.

Figure 4-2. BATTERY POLARITY AND CONNECTIONS

4-12. TROUBLESHOOTING

4-13. The purpose of troubleshooting is to locate and correct as quickly as possible any deficiency in operation. The causes and remedies of the more common troubles that may occur are listed in the troubleshooting chart, Figure 4-3. A complete understanding of the theory of operation and familiarity with the schematic diagram is the best means to locate and correct the cause of any malfunction.

Note!

Replacement of factory selected components that appear in Figure 4-4 will necessitate replacement of the entire set.

4-14. VISUAL INSPECTION

4-15. Troubles may sometimes be located by a thorough visual inspection. This may be accomplished by looking for the following symptoms:

a. Accumulations of dirt, dust, moisutre, or grease. Remove contamination as per paragraph 4-16.

b. Scorched or burned parts. Damage of this type is usually caused by other defective components. Determine the cause of damage before replacing damaged components.

c. Loose or broken connections.

4-16. PERIODIC MAINTENANCE

4-17. Periodic maintenance consists of occasional cleaning to remove dust, grease, and other contamination.

4-18. Clean the instrument as follows:

a. Remove accumulations of dust and other foreign matter with low-pressure, clean dry air.

SYMPTOM	PROBABLE CAUSE	REMEDY
Model 931 inoperative in ON/LINE OPR position.	F3 open. Power supply failure.	Replace fuse. Check voltage and components of regulator.
Model 931AB and 931PB inoperative in BAT OPR position.	F1 or F2 open Batteries dead.	Replace fuse. Recharge or replace batteries.
Model 931AB and 931PB inoperative in BAT OPR position. BAT CHECK OK	F2 open. BT2 dead.	Replace fuse. Replace batteries.
Model 931 measurements out of tolerance on every range with excessive meter drift.	Faulty regulated power supply.	Check voltage and components of regulators.

Figure 4-3. TROUBLESHOOTING CHART

INPUT SET	R1 R124 R126 R129 R130
TVM SET	R2 R3 R5
FIRST AND SECOND DIGIT SWITCH SET	R11 R12 R14 R16 R20 R22 R24 R26
SECOND AMPL SET	R118 R119 R122 R231
ZENER SET	CR106 R150 R237

Figure 4-4. FACTORY SELECTED COMPONENT SETS

b. Clean all external instrument surfaces with anhydrous ethyl alcohol, or an aerosol can of Freon TF Degreaser (Miller-Stephenson Chemical Co., Inc.) and, if necessary, a clean cloth or cotton swab.

c. When necessary, clean all exposed dielectric surfaces of switches with denatured alcohol using a small, stiff-bristle brush wrapped in a clean cloth.

CAUTION!

Do not use Metriclene, acetone, lacquer, thinner, or any ketone, since they will react with Lexan switch rotors. Also, be careful not to saturate the switch contacts, which have been lubricated for life.

d. Clean the internal areas with clean dry air.

4-19. PERFORMANCE TESTING

4-20. The following performance tests are to be used to ascertain the operational condition of the Model 931. Failure of the Model 931 to meet the performance test indicates the need of corrective maintenance and/or calibration.

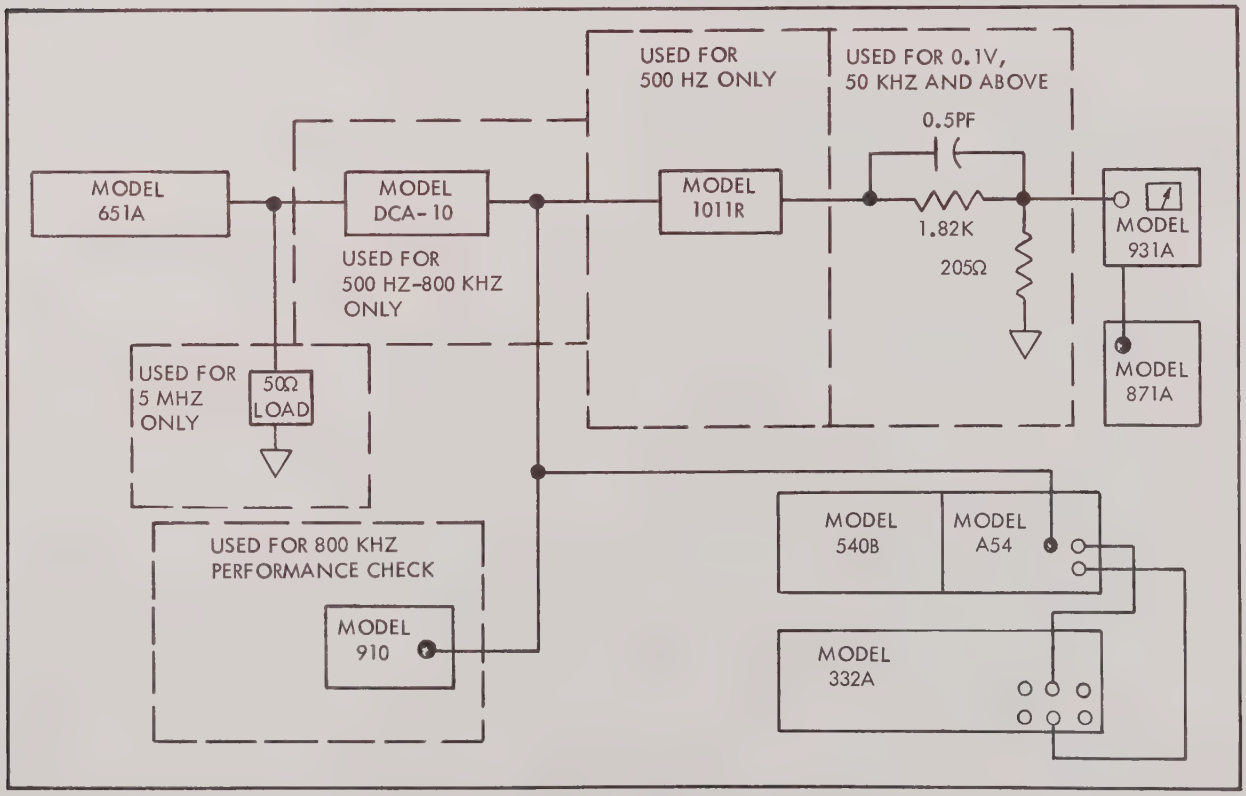


Figure 4-5. CALIBRATION EQUIPMENT CONNECTIONS

4-21. PRELIMINARY PERFORMANCE TESTING PROCEDURES

4-22. It is necessary to provide 0.1 volt, 0.11 volt, 1 volt, 10 volts, and 100 volts at frequencies of 500 Hz 50 kHz and 800 kHz.

4-23. For frequencies of 500 Hz through 5 MHz, equipment connections are illustrated by Figure 4-5.

4-24. The following equipment settings may be used to provide a calibrated signal to the Model 931 for frequencies of 500 Hz through 800 kHz. During performance testing of the Model 931 a calibrated signal at 800 kHz may be provided by connecting the Model 651A oscillator directly to the Model 931 input while monitoring the signal level with the Model 910:

CAUTION!

When connecting the dc source to the Model 540B, connect the grounded side of the dc source, if applicable, to the lower dc input post. The lower dc input post is connected directly to the chassis ground of the Model 540B.

a. Set the power switch of the Model 540B to REFERENCE, GALV, and SEARCH positions. If the meter needle indicates in the green battery region for each of the battery check positions, the batteries are satisfactory.

b. Set the switches on the Model 540B as follows:

MODE	OFF
GALV	OPEN
SENSITIVITY	LOW
POWER	ON

c. Connect the output of the Model 332A to the DC input of the A54-1, and set the output of the Model 332A to 10.0000 volts (observe polarity). The ratio transformer will be used to provide calibration voltages below 10 volts at 500 Hz only. If the ac-to-dc difference from a test report is being used, set the Model 332A output to $\frac{100}{100 + a_o}$ times the desired voltage, where a_o is the ac-to-dc percent difference at the center of the tee for the desired frequency.

Note!

When calibration requires an ac voltage of 100 volts, it will be necessary to reset the calibrating source by performing steps c through o with the Model 332A initially set to 100.000 volts. The Ratio Trans may be omitted from the circuit. Adjusting the calibrating circuit individually to 100 volts provides better accuracy at the lower calibrating voltages.

d. Set the range switch as close as possible to the dc voltage desired.

e. Set the mode switch to DC SEARCH.

f. The search meter should indicate in the green band between 50% and 100% of full-scale. Note the indication of the search meter.

g. Set the mode switch to DC TRANSFER.

h. Null the galvanometer as follows:

(1) With the GALV switch open, adjust the GALV ZERO control to null the galvanometer.

(2) Tap the GALV switch to the MOMENTARY position. If the needle goes off scale, adjust the COARSE REFERENCE ADJUST control, and repeat until the needle stays on scale.

(3) Set the GALV switch to lock.

(4) Adjust COARSE and MEDIUM REFERENCE ADJUST controls for galvanometer null.

(5) Set SENSITIVITY switch to MEDIUM, and rotate MEDIUM REFERENCE ADJUST control for galvanometer null.

(6) Set SENSITIVITY switch to HIGH, and rotate FINE REFERENCE ADJUST control for a null.

(7) Set GALV switch to open.

i. To test for dc reversal error, push the button on the A54 and note galvanometer offset. If necessary, adjust the REFERENCE ADJUST controls so as to reduce the offset by 50%: equal galvanometer offset should now be present in both polarities of the Model 332A.

j. Set the MODE switch to AC SEARCH.

k. Adjust ac voltage source until search meter indicates the voltage noted in step f.

l. Set MODE switch to AC TRANSFER.

m. With GALV switch open, adjust the GALV ZERO control to the null galvanometer.

n. Set GALV switch to lock, and null the galvanometer by adjusting the ac voltage source, with the SENSITIVITY switch in the LOW, MED, and HIGH positions. Do <u>not</u> adjust the REFERENCE ADJUST controls.

o. The rms value of the ac voltage is now equal to the Model 332A voltage.

Note!

Fluke standard laboratory or NBS test reports for the Model 540B are available at extra cost from John Fluke Mfg. Co.

4-25. METER ZERO CHECK

4-26. With the power removed from the Model 931, check the meter for mechanical zero.

4-27. NULL SENSITIVITY CHECK

4-28. Perform the following steps to check the accuracy of the recorder output.

a. Set the controls on the Model 931 as follows:

MODE	NULL 10%
RANGE	100 MILLIVOLTS
READOUT DIALS	10-0-0-00
POWER	ON/LINE OPR
RECORDER OUTPUT ADJ	CALIBRATE

b. Connect a vtvm to the RECORDER OUTPUT terminals and apply 0.110 (±0.00011) volts 500 Hz to the input of the Model 931 from a calibration source, The vtvm should indicate 1.0 (±0.01) volts.

4-29. TVM MODE CHECK

4-30. Perform the following steps to check the TVM accuracy of the Model 931 using a 500 Hz signal.

a. Place the controls of the Model 931 as follows:

POWER	ON/LINE OPR
MODE	TVM X1
RANGE	100 MV
Readout Dials	10-0-0-00

b. Connect a vtvm to the RECORDER OUTPUT terminals and apply 0.100 (±0.1) volts, 500 Hz from a calibration source to the input of the Model 931. The vtvm should indicate 1.0 (±0.01) volts and the Model 931 meter should indicate within (±1-1/2) small division of end-scale.

c. Apply 0.03162 (±.1%) volts to the input of the Model 931 from a calibration source. The vtvm should indicate 0.316 volts (±10 mv).

d. Set the Model 931 MODE switch to TVM X.3.

e. Apply 0.03162 (±.1%) volts to the input of the Model 931 from a calibration source. The vtvm should indicate 1.0 volt (±10 mv).

f. Set the Model 931 MODE switch to TVM X.1.

g. Apply 0.010 (±.1%) volts to the input of the Model 931 from a calibration source. The vtvm should indicate 1.0 volt (±10 mv).

4-31. NULL MODE ACCURACY CHECK -- 500 KHZ

4-32. Perform the following checks to ascertain the accuracy of the Model 931 ranges at 500 Hz.

a. Connect the equipment, as illustrated in Figure 4-5, applying 500 Hz to the input of the ratio transformer with the voltage as indicated in Figure 4-6.

b. Place the Model 931 to the .1% Mode with 10-0-0-0 on the Readout dials except as noted in step five of Figure 4-6.

c. With the Model 931 RANGE switch as indicated by Figure 4-6, compare the Model 931 dialed voltage to the ratio transformer voltage indicated in Figure 4-6.

4-33. NULL MODE ACCURACY CHECK -- 50 KHZ AND 800 KHZ

4-34. Perform the following checks to ascertain the accuracy of Model 931 ranges at 50 kHz and 800 kHz.

a. Connect the equipment, as illustrated in Figure 4-5, with the Model 931 readout dials to 10-0-0-0, except as noted, and the MODE switch to .1%.

b. With the Model 931 RANGE switch in the position indicated in Figure 4-7, apply the voltage indicated in Figure 4-7 to the Model 931 input.

STEP	RATIO TRANSFORMER		931 RANGE	MAXIMUM PERCENT ERROR on 931 Meter ±(0.05% of input +0.005% of range).
	500 Hz Input Voltage	Output Voltage to 931		
1	10v ±85 ppm	100 mv	100 mv	
2	10v ±85 ppm	1000 mv	1000 mv	
3	10v ±85 ppm	10v	10v	
4	100v	100v	100v	
5	100v	100v	1000v	Place Readout Dials to 01-0-0-00

Figure 4-6. 500 HZ RANGE CHECK SETTINGS

931 INPUT VOLTAGE	931 RANGE	NULL AT 50 KHZ	NULL AT 800 KHZ
100 MV	100 MV	±(0.05% of input +0.005% of range)	±4% of input*
1000 MV	1000 MV	±(0.05% of input +0.005% of range)	±4% of input*
10V	10V	±(0.05% of input +0.005% of range)	±4% of input*
100V	100V	±(0.05% of input +0.005% of range)	±4% of input*
* Includes ±1% accuracy of the Model 910.			

Figure 4-7. 50 AND 800 KHZ RANGE CHECK SETTINGS

c. Compare the Model 931 dialed voltage to the Model 931 input voltage at 50 kHz and 800 kHz, as indicated in Figure 4-7.

Note!

The Fluke Model 910 may be used to monitor the input signal level to the Model 931 at 800 kHz.

4-35. DIGIT CHECK

4-36. Perform the following check to ascertain the accuracy of the Model 931 DIGIT readout.

a. Place the Model 931 controls to the following positions:

POWER	ON/LINE OPR
RANGE	10 VOLTS
MODE	.1%
Readout Dials	10-0-0-00

b. Connect the equipment, as illustrated in Figure 4-5, to the input of the Model 931 and apply a 10 volt 500 Hz signal to the input of the ratio transformer.

c. Compare the Model 931 dialed voltage to the ratio transformer voltage as indicated in Figure 4-8.

4-37. OVERLOAD PROTECTION CHECK

4-38. Perform the following steps to check the operation of the overload protection circuits.

a. Place the Model 931 controls to the following positions:

POWER	ON/LINE OPR
MODE	TVM X1
RANGE	100 MILLIVOLTS
Readout Dials	10-0-0-00

b. Apply a 200 mv 500 Hz signal to the Model 931 input.

c. Listen for chattering of the overload relay.

d. Progressively place the MODE switch from the TVM X1 position to the NULL .1% position, observing that the overload relay chatters in all positions.

e. Apply 100 mv 500 Hz to the Model 931 input and null the instrument in .1% Mode.

f. Apply 200 mv 500 Hz to the Model 931 input for 5 seconds and then reduce the level to 100 mv.

g. Observe that the meter reading returns to within 100 ppm of null within one minute.

4-39. CALIBRATION PROCEDURES

4-40. The Model 931 should be calibrated once every 90 days. It is recommended that if any component replacement is performed, the Model 931 should be recalibrated. Test equipment specifications are listed in Figure 4-1.

4-41. PRECALIBRATION ADJUSTMENTS

4-42. The following adjustments are to be performed if corrective maintenance has been performed to the corresponding Model 931 circuit. Adjustments and test points are illustrated in Figure 4-9.

DIGIT UNDER TEST	MODEL 931 AND RATIO TRANSFORMER READ-OUT	MODEL 931 MAXIMUM PERCENT ERROR
1	8-0-0-0 4-0-0-0 2-0-0-0 1-0-0-0	±(0.05% of input +0.005% of range) for all settings
2	1-0-0-0 1-1-0-0 1-2-0-0 1-4-0-0 1-8-0-0	
3	1-0-0-0 1-0-1-0 1-0-2-0 1-0-4-0 1-0-8-0	
4	1-0-1-0 1-0-0-10 1-0-0-5 1-0-0-1	

Figure 4-8. DIGIT CHECK SETTINGS

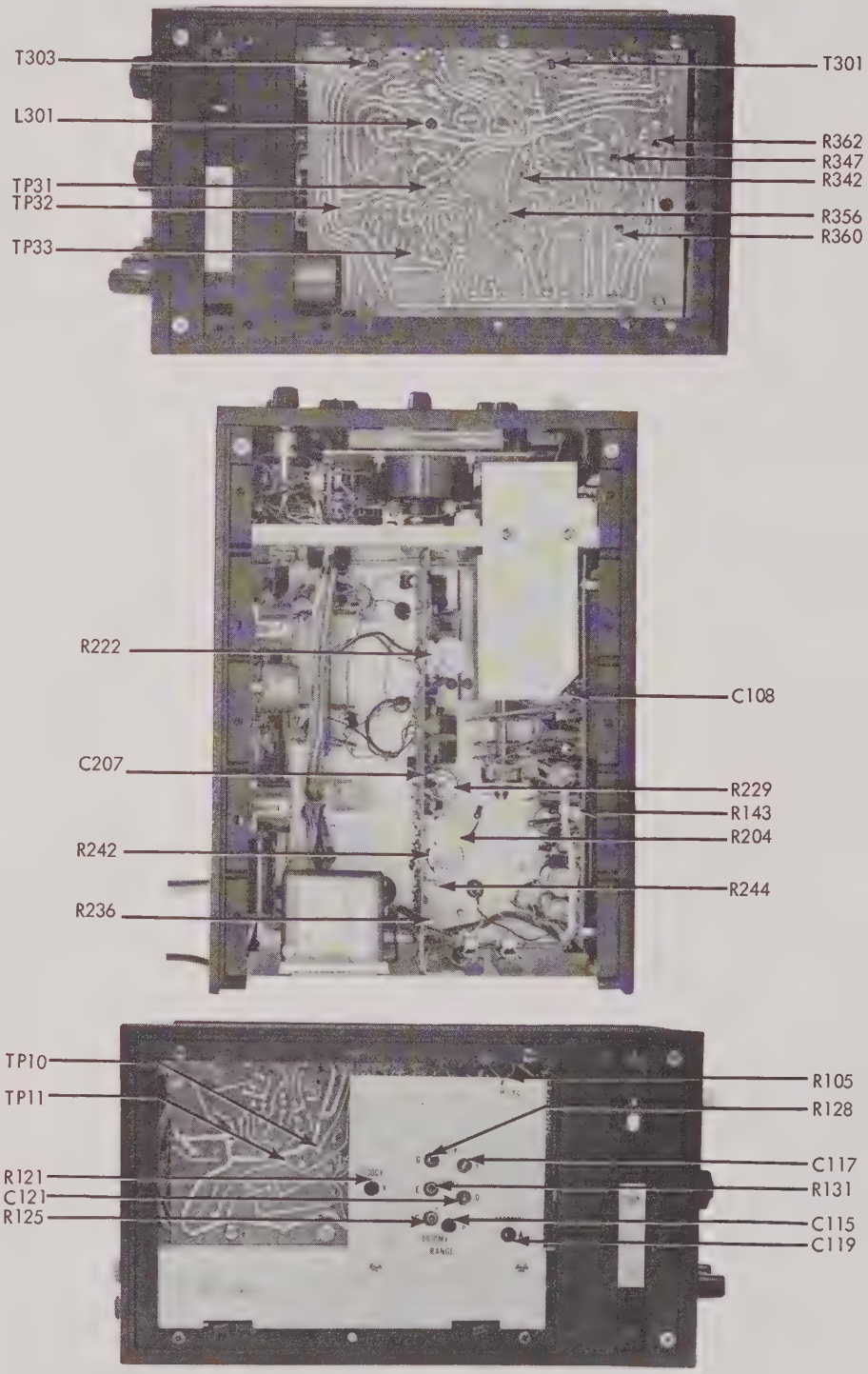


Figure 4-9. TEST AND ADJUSTMENT POINTS

4-43. REGULATED POWER SUPPLY

4-44. Connect the equipment as shown in Figure 4-10 and set the Model 931 switches to the following positions:

POWER	ON/LINE OPR
RANGE	100 MILLIVOLTS
MODE	NULL 10%
Readout Dials	10-0-0-00

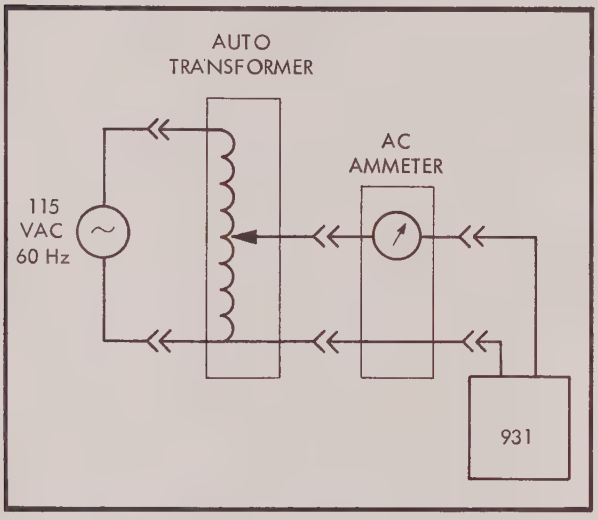


Figure 4-10. REGULATION TEST EQUIPMENT CONNECTIONS

a. Apply 115 volts ac through the autotransformer to the input of the Model 931. The current indicated by the ac ammeter should be less than 60 ma rms.

b. Place the POWER switch to BAT CHG LINE OPR, Model 931AB & 931PB only. The maximum line current should be less than 220 ma rms. Return the switch to LINE OPR upon completion of step b.

c. Check the voltage at TP10 and adjust R143, adjustment L, until voltage is +14.5 volts dc (±4 mv).

d. Increase the input voltage to the Model 931 with the autotransformer control until it reaches 130 volts ac while monitoring TP10. The voltage should not vary.

e. Decrease the input voltage to the Model 931 with the autotransformer control until it is 115 volts ac.

f. Observe the voltage at TP10 with an oscilloscope. The ripple shall be less than 5 mv rms at autotransformer settings of steps d and e.

g. Check the voltage at TP11. It should be -13.9 to -14.6 vdc.

h. Observe the voltage at TP11 while varying autotransformer control as in step d and e. The voltage should not vary.

i. Observe the voltage at TP11 with an oscilloscope. The ripple shall be less than 5 mv rms at autotransformer settings of step h.

4-45. AMPLIFIER BIAS

4-46. With the Model 931 connected to a 115 volt ac source, place the Model 931 switches to the following positions:

POWER	ON/LINE OPR
RANGE	100 MILLIVOLTS
MODE	TVM X.1
Readout Dials	10-0-0-00

a. Monitor voltage at TP25 and adjust R105, adjustment H, until the voltage at TP25 is 0, ±.02 volts dc.

b. Monitor voltage at TP20 and adjust R204, adjustment M, until the voltage at TP20 is between +3.5 and +4.0 volts dc. (This adjustment has a long time constant and requires patience.)

c. Monitor voltage at TP22 and adjust R222, adjustment P, until the voltage at TP22 is 0, ±.02 volts dc.

4-47. OSCILLATOR FREQUENCY

4-48. With the Model 931 connected to a 115 volt ac source, place the Model 931 switches to the following positions:

POWER	ON/LINE OPR
MODE	TVM X1
RANGE	1000 MILLIVOLTS
Readout Dials	10-0-0-00

a. Connect a frequency counter to TP30.

b. Rotate the adjustment labeled S with a plastic screwdriver until the frequency is 2500 (±5) Hz.

4-49. CARRIER AMPLIFIER

4-50. With the Model 931 connected to a 115 volt ac source, place the Model 931 switches to the following positions:

POWER	ON/LINE OPR
MODE	TVM X1
RANGE	1000 MILLIVOLTS
Readout Dials	10-0-0-00

a. Short TP32 and 33 to ground.

b. Connect an oscilloscope input to TP31 and the oscilloscope external trigger to TP30.

c. Connect the H. P. 651 oscillator output directly to the Model 931 input and set the H. P. 651 frequency to 500 Hz.

d. Increase the output of the H. P. 651 until a visible positive increase of the 5 kHz demodulated signal is observed on the oscilloscope, as illustrated in Figure 4-11A or B.

e. Rotate adjustments R and T with a plastic screwdriver for maximum positive output. The H. P. 651 signal may have to be reduced to prevent saturation of the amplifier as the peak signal is approached.

f. Adjust R and T until the signal is in phase with the demodulator as illustrated in Figure 4-11A and B.

g. Remove the shorts from TP32 and 33 and adjust the H. P. 651 output until the Model 931 indicates approximately 1 volt.

h. Monitor the waveform at TP31 with an oscilloscope. If the peak-to-peak voltage observed on the oscilloscope exceeds 4 volts, the modulator T302 should be replaced.

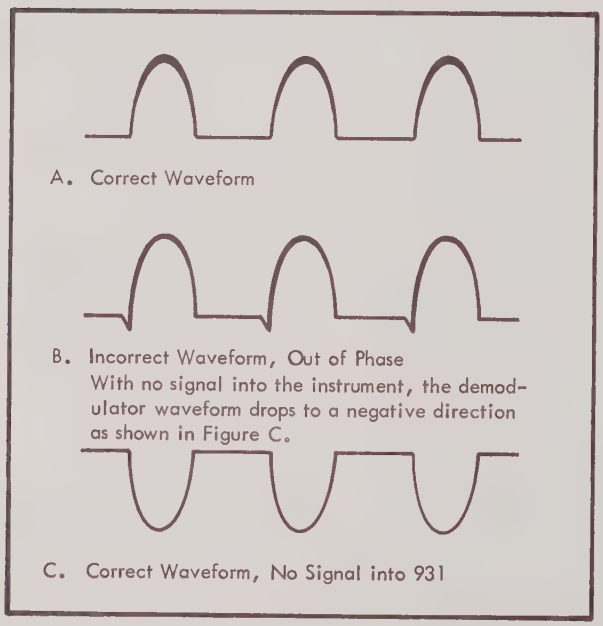

A. Correct Waveform
B. Incorrect Waveform, Out of Phase
With no signal into the instrument, the demodulator waveform drops to a negative direction as shown in Figure C.
C. Correct Waveform, No Signal into 931

Figure 4-11. CARRIER AMPLIFIER WAVEFORMS

4-51. CALIBRATION

4-52. The following adjustments are to be performed during calibration of the Model 931. Equipment connections are illustrated in Figure 4-5. Calibration equipment settings are contained in paragraph 4-24 and 4-53.

4-53. EQUIPMENT SETTINGS FOR 5 MHZ

4-54. The following equipment settings may be used to provide a calibrated 1.0 (±5%) volt at 5 MHz to the input of the Model 931:

a. Connect the Hewlett-Packard 651A oscillator through the coaxial cable to the input of the Model 931 in parallel with the 50-ohm load.

b. Adjust the output level of the Hewlett-Packard 651A oscillator at 5 MHz for 1 volt as indicated on its output meter.

Note!

To obtain 0.100 (±0.005) volts at 5 MHz it will be necessary to apply 1.00 (±0.05) volts to the divider illustrated by Figure 4-5.

4-55. RECORDER OUTPUT ADJUSTMENTS

a. Connect a vtvm to the RECORDER OUTPUT terminals.

b. Place the Model 931 controls to the following positions:

RECORDER OUTPUT ADJ	CAL
POWER	ON/LINE OPR
MODE	TVM X1
RANGE	1000 MILLIVOLTS
Readout Dials	10-0-0-00

c. Adjust R342, adjustment V, until the vtvm indicates 0 (±.0005) volts.

4-56. ZERO OFFSET ADJUSTMENT

a. Place the Model 931 controls to the following positions:

POWER	ON/LINE OPR
MODE	NULL .1%
RANGE	100 MILLIVOLTS
Readout Dials	10-0-0-00

b. Push the PUSH TO CAL control, and adjust for the center of range, 5 turns from either end.

c. Apply 0.100 (±.1%) volts rms at 500 Hz, from a calibration source, to the input of the Model 931.

d. Adjust R242 and R244 for a null of 0 (±0.01%) volts indication on the vtvm located at the RECORDER OUTPUT.

e. Place MODE switch to NULL 10% and adjust R347, adjustment X, for 0 (±2 mv) indication on the vtvm located at the RECORDER OUTPUT.

4-57. SENSITIVITY METER ADJUSTMENTS

a. Place the Model 931 controls to the following positions:

POWER	ON/LINE OPR
MODE	NULL .1%
RANGE	100 MILLIVOLTS
Readout Dials	10-0-0-00

b. Apply a 0.100 (±.1%) volt rms, 500 Hz signal, from a calibration source, to the input of the Model 931.

c. Adjust R362, adjustment Z, for 1.0 (±2 mv) volt indication on the vtvm located at the RECORDER OUTPUT.

d. Apply a 0.100 (±.1%) volt rms, 500 Hz signal, from a calibration source, to the input of the Model 931.

e. Place the Model 931 MODE switch to TVM X1.

f. Adjust R356, adjustment W, for 1.0 (±1 mv) volt indication on the vtvm located at the RECORDER OUTPUT.

g. Repeat steps a through e since the adjustments interact.

h. With the vtvm indicating 1 volt from step e, adjust R360, adjustment Y, until the Model 931 meter indicates full scale ±1/4 small divisions of the 1-0-1 scale.

4-58. 5 MHZ ADJUSTMENTS

4-59. It is necessary to provide 0.100 and 1.00 volts rms at 5 MHz. Equipment connections are illustrated in Figure 4-5, and equipment settings are contained in paragraph 4-53.

a. Place the Model 931 controls to the following positions:

POWER	ON/LINE OPR
RANGE	1000 MILLIVOLTS
MODE	TVM X1
Readout Dials	10-0-0-00

b. Apply a 1.00 (±0.05) volt 5 MHz signal, from a calibration source, to the input of the Model 931.

c. Adjust C207, adjustment N, so that the Model 931 meter indicates 0.96 (±0.02) volts.

d. Apply a 1.00 (±0.05) volt 5 MHz, to the divider illustrated in Figure 4-5. The input to the Model 931 via the divider is .1 volt.

e. Place the RANGE switch to 100 MILLIVOLTS.

f. Adjust C108, adjustment J, so that the Model 931 meter indicates 0.92 (±0.02) volts.

4-60. DIGIT ATTENUATOR ADJUSTMENT

a. Place the Model 931 controls to the following positions:

POWER	ON/LINE OPR
MODE	NULL .1%
RANGE	1000 MILLIVOLTS
Readout Dials	10-0-0-00

b. Apply a 10 volt rms, 500 Hz, signal from a calibration source to the input of the ratio transformer as illustrated in Figure 4-5.

c. Apply the output of the ratio transformer to the input of the Model 931 and compare the Model 931 dialed voltage to the ratio transformer voltage as illustrated in Figure 4-12.

4-61. RATIO ADJUSTMENTS - 500 HZ

a. Place the Model 931 controls to the following positions:

POWER	ON/LINE OPR
MODE	NULL .1%
RANGE	100 MILLIVOLTS
Readout Dials	10-0-0-00

b. Apply 0.100 (±0.00001) volts rms at 500 Hz, from the calibration source to the Model 931 input. Adjust R242 and R244 for a meter deflection of 0±30 ppm.

c. Place the RANGE switch to 1000 MILLIVOLTS, and apply 1.000 (±0.0001) volt, rms at 500 Hz from the calibration surce to the Model 931 input.

d. Adjust R125, adjustment C, for a meter deflection of 0±30 ppm.

e. Place the RANGE switch to 10 VOLTS and apply 10 (±0.0001) volt rms at 500 Hz, from the calibration source to the Model 931 input.

f. Adjust R131, adjustment E, for a meter deflection of 0±30 ppm.

g. Repeat step b. If the drift has exceeded ±40 ppm, repeat steps b through f.

DIGIT UNDER TEST	MODEL 931 AND RATIO TRANSFORMER READ-OUT	MODEL 931 MAXIMUM PERCENT ERROR
1	8-0-0-0	Set to null with R244
	4-0-0-0	±.010
	2-0-0-0	±.015
	1-0-0-0	±.020
2	1-0-0-0	Set to null with R244
	1-1-0-0	±.010
	1-2-0-0	±.010
	1-4-0-0	±.010
	1-8-0-0	±.010
3	1-0-0-0	Set to null with R244
	1-0-1-0	±.010
	1-0-2-0	±.010
	1-0-4-0	±.010
	1-0-8-0	±.010
4	1-0-1-0	Set to null with R244
	1-0-0-100	Adj Q to obtain null
	1-0-0-50	±.010
	1-0-0-10	±.010

Figure 4-12. DIGIT ATTENUATOR SETTINGS

h. Place the RANGE switch to 100 VOLTS. Apply 100 (±0.001) volts rms at 500 Hz, from the calibration source to the Model 931 input.

i. Adjust R128, adjustment G, for a meter deflection of 0±30 ppm.

j. Place the RANGE switch to 1000 VOLTS, and place the DIGITS to 1000.

k. Adjust R121, adjustment K, for a meter deflection of 0±30 ppm.

l. Repeat step h. If the drift has exceeded ±40 ppm repeat the procedure from step h through k.

4-62. RATIO ADJUSTMENTS - 50 KHZ

a. Place the Model 931 controls to the following positions:

POWER	ON/LINE OPR
MODE	NULL .1%
RANGE	100 MILLIVOLTS
Readout Dials	10-0-0-00

b. Apply 0.100 (±0.00001) volt rms at 50 kHz, from the calibration source to the Model 931 input.

c. Adjust C119, adjustment A, for a meter deflection of 0±30 ppm.

d. Place the RANGE switch to 1000 MILLIVOLTS.

e. Apply 1.000 (±0.0001) volt rms at 50 kHz, from the calibration source to the input of the Model 931.

f. Adjust C115, adjustment B, for a meter deflection of 0±30 ppm.

g. Place the RANGE switch to 10 VOLTS.

h. Apply 10 (±0.001) volts rms at 50 kHz, from the calibration source to the Model 931 input.

i. Adjust C121, adjustment D, for a meter deflection of 0±30 ppm.

j. Place the RANGE switch to 100 VOLTS.

k. Apply 100 (±0.01) volts rms at 50 kHz, from the calibration source to the Model 931 input.

l. Adjust C117, adjustment F, for a meter deflection of 0±30 ppm.

Note!

Factory selected capacitors are used to pad the adjustments of paragraph 4-62. Replacement of padding capacitors with a different value may be necessary during calibration to bring the adjustments within tolerance.

4-63. ABSOLUTE CALIBRATION ADJUSTMENTS

a. Place the Model 931 controls to the following positions:

POWER	ON/LINE OPR
MODE	NULL .1%
RANGE	10 VOLTS
Readout Dials	10-0-0-00

b. Push the PUSH TO CAL control, and adjust for the center of its range, 5 turns from either end.

c. Adjust R236 until fully clockwise.

d. Push to PUSH TO CAL control and adjust R224 and R242 for a meter deflection of 0±20 ppm.

CAUTION!

Do not rotate PUSH TO CAL control during step d.

e. Apply 10 (±0.001) volts rms at 500 Hz, from the calibration source to the input of the Model 931.

f. Rotate the Model 931 readout dials until a meter deflection of 0±20 ppm occurs.

g. Compare the readout dialed voltage on the Model 931 to that indicated in Figure 4-13 and select the appropriate jumper wire. Jumper wire locations are illustrated in Figure 4-14.

VOLTAGE DIALED ON DIGIT SWITCHES		CAL CURRENT JUMPER WIRES TO CUT
9.6841	9.7303	#1, 2, 4
9.7303	9.7765	#2, 4
9.7765	9.8227	#1, 4
9.8227	9.8689	#4
9.8689	9.9151	#1, 2
9.9151	9.9613	#2
9.9613	10.0075	#1
10.0075	10.9537	None

Figure 4-13. ABSOLUTE CALIBRATION JUMPER SELECTION

h. Place the Model 931 readout dials to 10-0-0-00.

i. Adjust R242 and R244 for a meter deflection of 0±20 ppm.

j. Push the PUSH TO CAL control, being careful not to rotate it. Then adjust R236 for a meter deflection of 0±20 ppm.

k. If, upon release of the PUSH TO CAL control a meter deflection of greater than ±50 ppm occurs repeat steps a through k.

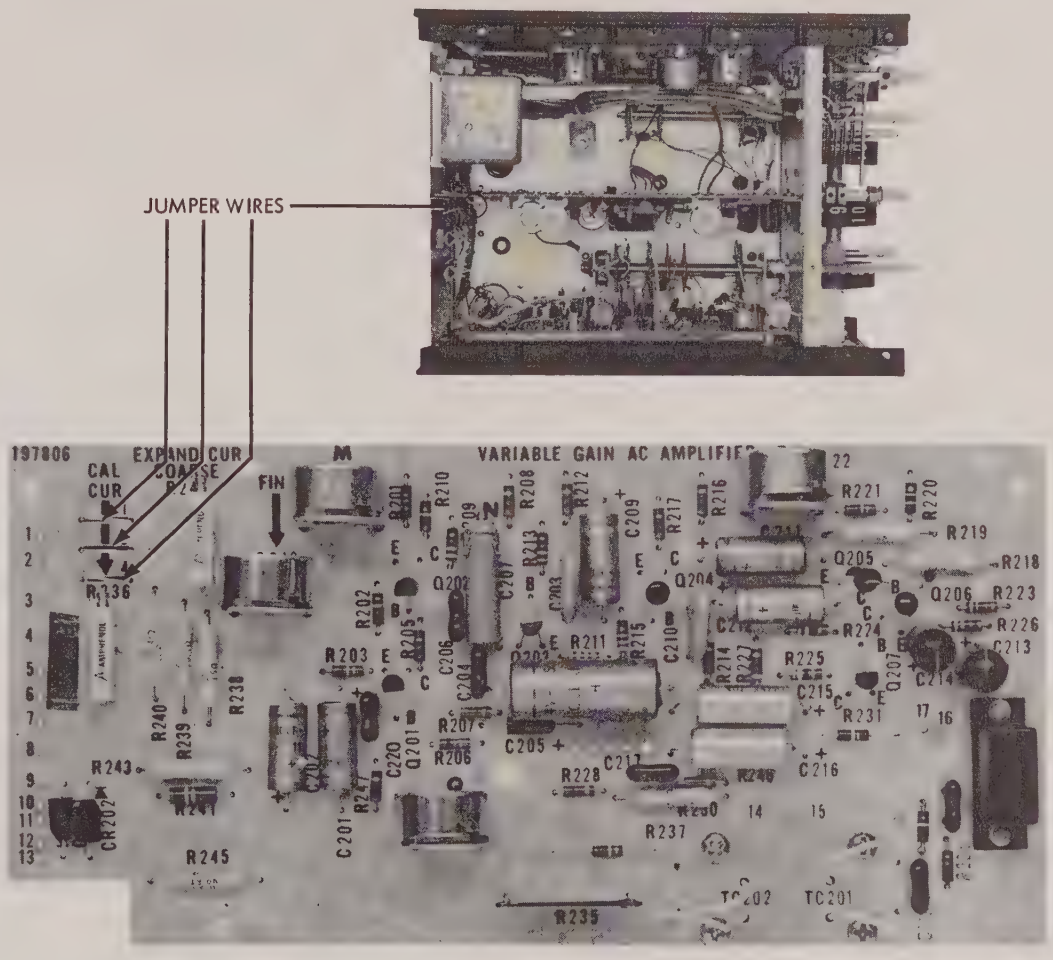


Figure 4-14. ABSOLUTE CALIBRATION JUMPER WIRE LOCATION

SECTION V

LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section contains complete descriptions of those parts one might normally expect to replace during the life of the instrument. The first listing is a breakdown of all of the major assemblies in the instrument. Subsequent listings itemize the components in each assembly. Every listing is accompanied by an illustration identifying each component in the listing. Assemblies and subassemblies are identified by a reference designation beginning with the letter A, (e.g., A1, etc.). Components are identified by the schematic diagram reference designation (e.g. R1, C107, DS1). Parts not appearing on the schematic diagram are identified by only a location index number. Flagnotes are used throughout the parts list and refer to ordering explanations. The flagnote explanations appear at the end of the parts list.

5-3. COLUMNAR INFORMATION

a. The REF DESIG column indexes the item description to the associated illustration. In general the reference designations are listed under each assembly in alpha-numeric order. Subassemblies of minor proportions are sometimes listed with the assembly of which they are a part. In this case, the reference designations for the components of the subassembly may appear out of order.

b. The INDEX NO. column lists coordinates which locate the designated part on the associated illustration.

c. The DESCRIPTION column describes the salient characteristics of the component. Indention of the description indicates the relationship to other assemblies, components, etc. In many cases it is necessary to abbreviate in this column. For abreviations and symbols used, see the following page.

d. The ten-digit part number by which the item is identified at the John Fluke Mfg. Co. is listed in the STOCK NO. column. Use this number when ordering parts from the factory or authorized representatives.

e. The Federal Supply Code for the item manufacturer is listed in the MFR column. An abbreviated list of Federal Supply Codes is included in the Appendix.

f. The part number which uniquely identifies the item to the original manufacturer is listed in the MFR PART NO column. If a component must be ordered by description, the type number is listed.

g. The TOT QTY column lists the total quantity of the item used in the instrument. Second and subsequent listing of the same item are referenced to the first listing with the abbreviation REF. In the case of optional subassemblies, plug ins, etc. that are not always part of the instrument, the TOT QTY column lists the total quantity of the item in that particular assembly.

h. Entries in the REC QTY column indicate the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of every part in the instrument be stocked.

i. The USE CODE column identifies certain parts which have been added, deleted or modified during the production of the instrument. Each part for which a Use Code has been assigned may be identified with a particular instrument serial number by consulting the Serial Number Effectivity List at the end of the parts list. As Use Codes are added to the list, the TOT QTY column listings are changed to reflect the most current information. Sometimes when a part is changed, the new part can and should be used as a replacement for the original part. In this event a parenthetical note is added in the DESCRIPTION column.

5-4. HOW TO OBTAIN PARTS

5-5. Standard components have been used wherever possible. Standard components may be ordered directly from the manufacturer by using the manufacturer's part number, or parts may be ordered from the John Fluke Mfg. Co. factory or authorized representative by using the Fluke part number. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-6. You can insure prompt and efficient handling of your order to the John Fluke Mfg. Co. if you include the following information:

a. Instrument model and serial number.
b. Component description.
c. Component reference designation.
d. John Fluke Mfg. Co. part number.

If you must order structural parts not listed in the parts list, describe the part as completely as possible. A sketch of the part showing its location to other parts of the instrument is usually most helpful.

5-7. LIST OF ABBREVIATIONS

ac	alternating current
Al	Aluminum
amp	ampere
assy	assembly
cap	capacitor
car flm	carbon film
C	centigrade
cer	ceramic
comp	composition
conn	connector
db	decibel
dc	direct current
dpdt	double-pole, double-throw
dpst	double-pole, single-throw
elect	electrolytic
F	fahrenheit
Ge	germanium
gmv	guaranteed minimum value
h	henry
Hz	hertz
hf	high frequency
IC	integrated circuit
if	intermediate frequency
k	kilohm
kHz	kilohertz
kv	kilovolt
lf	low frequency
MHz	megahertz
M	megohm
met flm	metal film
ua	microampere
uf	microfarad
uh	microhenry
usec	microsecond
uv	microvolt
ma	milliampere
mh	millihenry
m	millohms
msec	millisecond
mv	millivolt
mw	milliwatt
na	nanoampere
nsec	nanosecond
nv	nanovolt
Ω	ohm
ppm	parts per million
piv	peak inverse voltage
p-p	peak to peak
pf	picofarad
plstc	plastic
p	pole
pos	position
P/C	printed circuit
rf	radio frequency
rfi	radio frequency interference
res	resistor
rms	root mean square
rtry	rotary
sec	second
sect	section
S/N	serial number
Si	silicon
scr	silcon controlled rectifier
spdt	single-pole, double-throw
spst	single-pole, single-throw
sw	switch
Ta	tantalum
tstr	transistor
tvm	transistor voltmeter
uhf	ultr high frequency
vtvm	vacuum tube voltmeter
var	variable
vhf	very high frequency
vlf	very low frequency
v	volt
va	voltampere
vac	volts, alternating current
vdc	volts, direct current
w	watt
ww	wire wound

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		FINAL ASSEMBLY - Figure 5 - 1						
		Line-powered model	931A					
		Battery/Line-powered model	931AB					
		Line-powered model	931P					
		Battery/Line-powered model	931PB					
A1	H1-N4	Chassis Assembly (See Figure 5-2)						
A2	K1-R2	Front Panel Assembly (See Figure 5-3)						
A3	C2-R3	Rear Panel Assembly (See Figure 5-4)						
A4	J2-Q5	Switch Panel Assembly (See Figure 5-5)						
		(931A and 931P Line-powered models)	3158-197863 (931A-408)	89536	3158-197863	1		
		(931AB and 931PB Battery/Line-powered models)	3158-198119 (931AB-402)	89536	3158-198119	1		
A5	I2-T5	Input Amplifier and Power Supply Assy. (See Figure 5-8)	1702-197798 (931A-401)	89536	1702-197798	1		
A6	I2-R4	Variable Gain AC Amplifier Assembly (See Figure 5-9)	1702-197806 (931A-402)	89536	1702-197806	1		
A7	H5-P2	Null Detector Assembly (See Figure 5-10)	1702-197814 (931A-403)	89536	1702-197806	1		

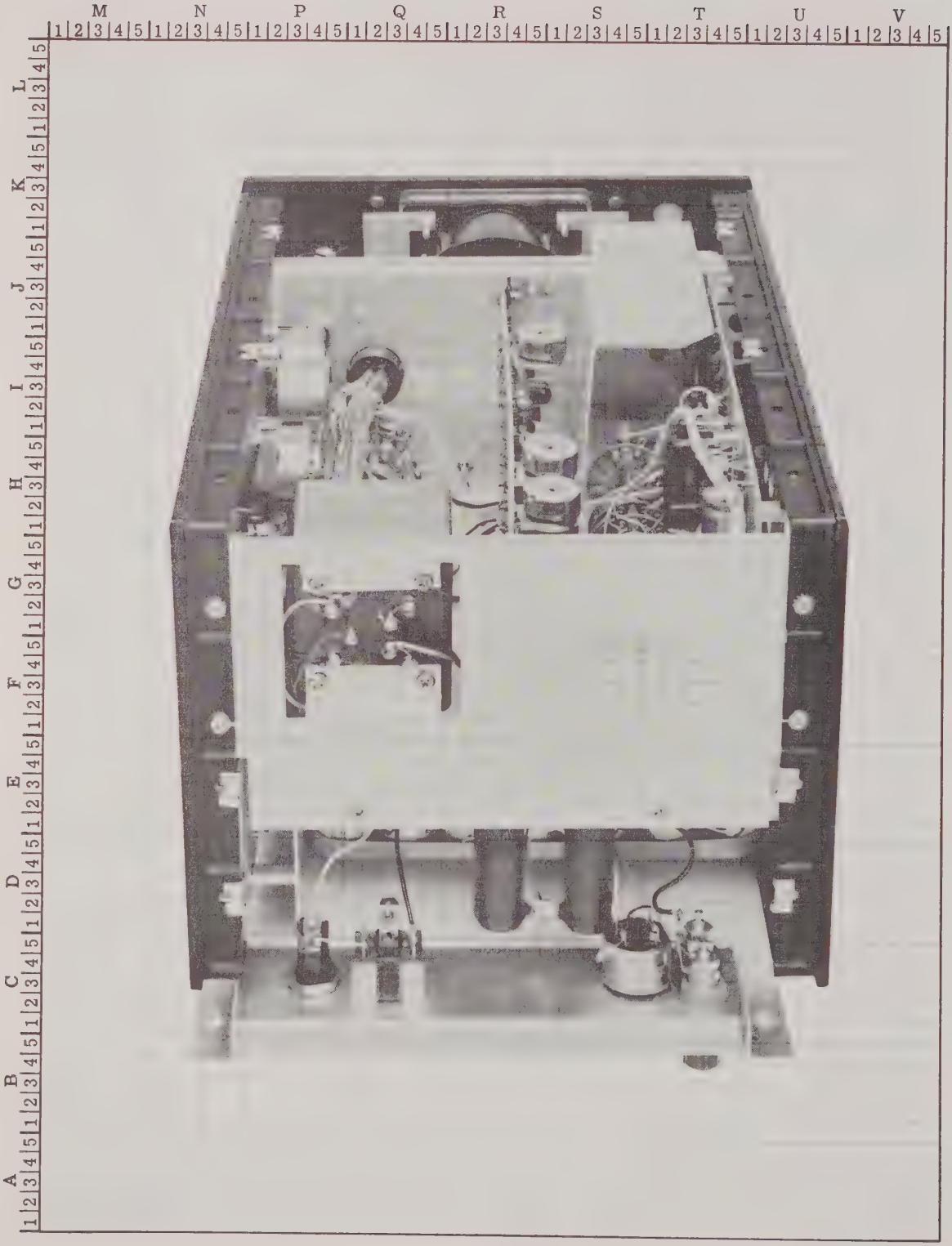


Figure 5-1. FINAL ASSEMBLY

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A1		CHASSIS ASSEMBLY - Figure 5-2						
BT1, BT2		Battery, 1.2v, Ni-Cad (931AB and 931PB only) (not illustrated)	4002-160390	05397	N53T	26		
F2, F3		Fuse, Type AGC, Fast act, 1/2 1/2 amp, 250v (931AB and 931PB only) (not illustrated)	5101-153858	71400	Type AGC	2	5	
R8	C5-N4	Res, power, 100Ω ±5%, 25w (931AB and 931PB only)	4706-190736	12400	2D	2		
R9	D3-N4	Res, power, 100Ω ±5%, 25w (931AB and 931PB only)	4706-190736	12400	2D	REF		
T1	K1-N5	Transformer, power	5602-192690	89536	5602-192690	1		
XBT1	D4-P5	Holder, battery (931AB and 931PB only)	3155-198093	89536	3155-198093	2		
XBT2		Holder, battery (931AB and 931PB only) (not illustrated)	3155-198093	89536	3155-198093	REF		
XF2	I3-N3	Holder, fuse (931AB and 931PB only)	2102-103283	71400	4405	2		
XF3	I1-N3	Holder, fuse (931AB and 931PB only)	2102-103283	71400	4405	REF		
	B2-Q4	Bail (sheet 2 of 2)	3153-163386	89536	3153-163386	1		
	B2-P4	Bail, foot (sheet 2 of 2)	3151-169904	89536	3151-169904	2		
	B2-T1	Bail, foot (sheet 2 of 2)	3151-169904	89536	3151-169904	REF		
	J1-T3	Coupling, 5/8 inch.	2402-196881	89536	2402-196881	2		
	J1-T4	Coupling, 5/8 inch.	2402-196881	89536	2402-196881	REF		
	J1-U1	Coupling, 1/2 inch.	2402-198374	89536	2402-198374	1		
	I1-S5	Coupling, 1/4 inch. to 1/4 inch.	2402-104505	89536	2402-104505	1		
	B3-R4	Cover, bottom (sheet 2 of 2)	1406-167627	89536	1406-167627	1		
	J2-P1	Cover, side (sheet 2 of 2)	1406-167635	89536	1406-167635	2		
		Cover, side (not illustrated)	1406-167635	89536	1406-167635	REF		
	J2-P5	Cover, side front (sheet 2 of 2)	1406-162164	89536	1406-162164	2		
		Cover, side front (not illustrated)	1406-162164	89536	1406-162164	REF		
	K5-Q2	Cover, top (sheet 2 of 2)	1406-167619	89536	1406-167619	1		
	C3-T4	Dial drum, 0-10	2403-162891	89536	2403-162891	3		
	D2-T4	Dial drum, 0-10	2403-162891	89536	2403-162891	REF		
	E2-T4	Dial drum, 0-10	2403-162891	89536	2403-162891	REF		

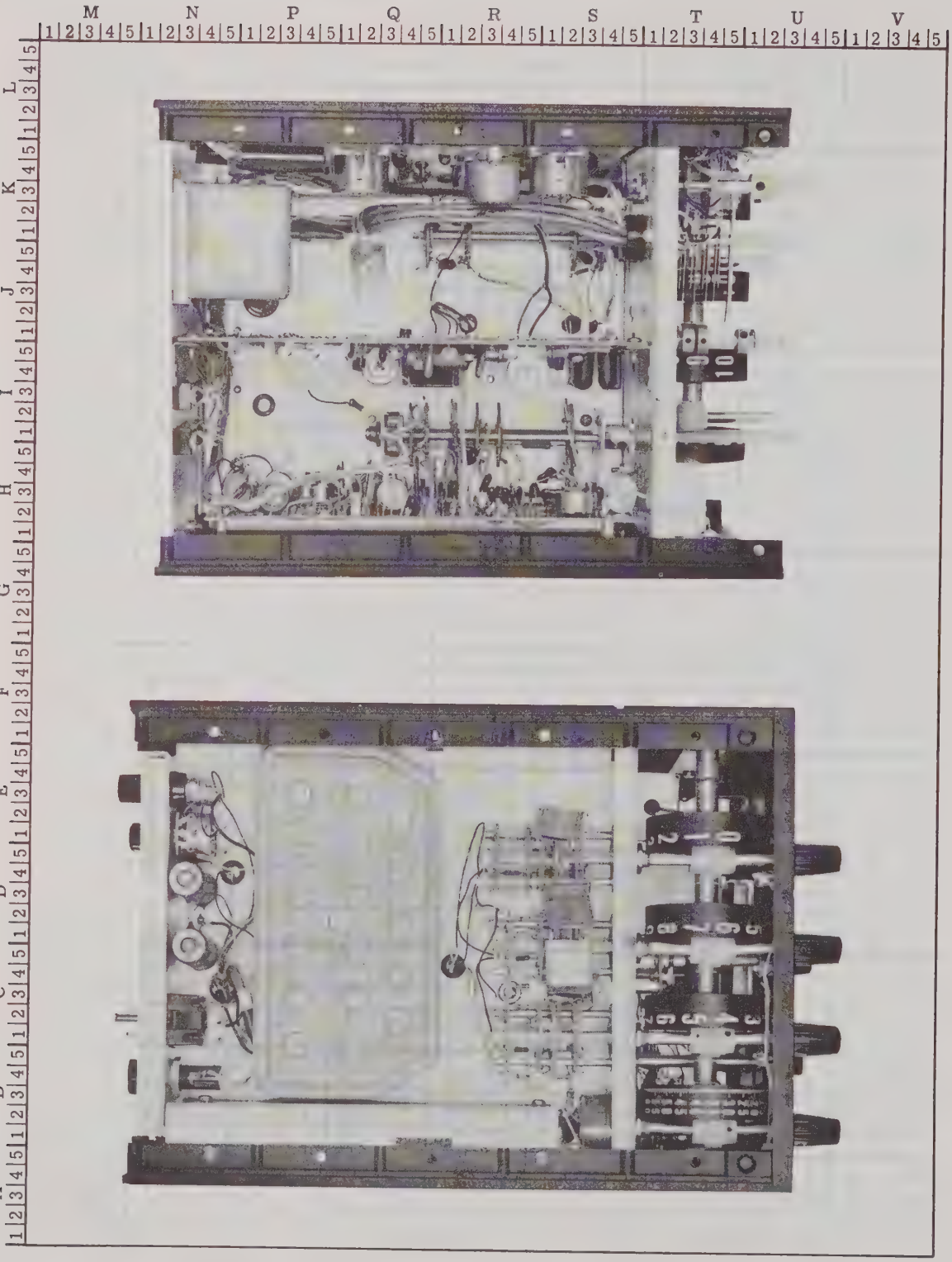


Figure 5-2. CHASSIS ASSEMBLY (Sheet 1 of 2)

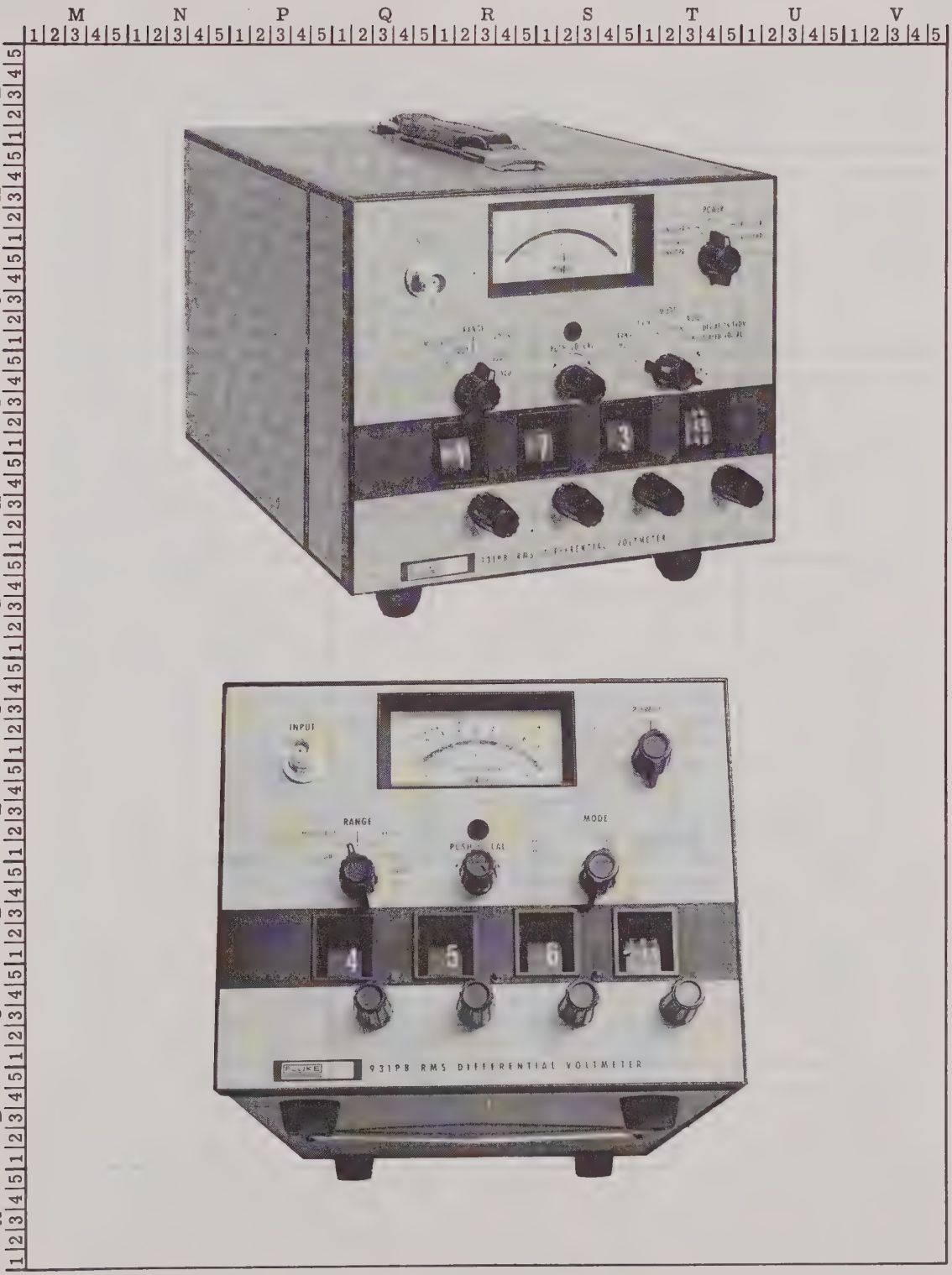

M N P Q R S T U V
1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5
A B C D E F G H I J K L
POWER
INPUT
RANGE
MODE
FLUKE
931PB RMS DIFFERENTIAL VOLTMETER

Figure 5-2. CHASSIS ASSEMBLY (Sheet 2 of 2)

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
	B3-T4	Dial drum, 0-100	2403-162909	89536	2403-162909	1		
	K4-U2	Extension, shaft	2402-178038	20584	custom	1		
	B3-P4	Foot, rubber (sheet 2 of 2)	2819-103309	77969	9102-W	4		
	A5-Q1	Foot, rubber (sheet 2 of 2)	2819-103309	77969	9102-W	REF		
	B3-T1	Foot, rubber (sheet 2 of 2)	2819-103309	77969	9102-W	REF		
	A5-S3	Foot, rubber (sheet 2 of 2)	2819-103309	77969	9102-W	REF		
	B2-T5	Gear, nylon	3155-154682	89536	3155-154682	4		
	C1-T5	Gear, nylon	3155-154682	89536	3155-154682	REF		
	D1-T5	Gear, nylon	3155-154682	89536	3155-154682	REF		
	D5-T5	Gear, nylon	3155-154682	89536	3155-154682	REF		
	L1-R1	Handle, black vinyl (sheet 2 of 2)	2404-101857	12136	919-415-173	1		
		Line cord (not illustrated)	6005-161638	91934	SVT-107-1	1		
	J1-U2	Shaft, cal pot	4711-197723	89536	4711-197723	1		
		Shaft, drum (not illustrated)	3153-171686	89536	3153-171686	1		
	I1-U2	Shaft, range switch	5108-197673	89536	5108-197673	1		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A2		**FRONT PANEL ASSEMBLY-Figure 5-3**						
DS1	C2-R2	Lamp, incandescent, 10v	3901-192120	89730	709	3	5	
DS2	C2-S3	Lamp, incandescent, 10v	3901-192120	89730	709	REF		
DS3	C2-Q1	Lamp, incandescent, 10v	3901-192120	89730	709	REF		
J1	E5-T2	Connector, female, coaxial Type BNC (931A and 931AB only)	2106-193250	91737	11823-1	1		
M1	E4-R3	Meter, 100-0-100 ua, 225Ω (931A and 931P only)	2901-195156	38315	Type MS24T	1		
M1	E4-R3	Meter, 100-0-100 ua, 325Ω (931A and 931P only)	2901-208959	80145	Type 302	1		
M1	E4-R3	Meter, 100-0-100 ua, 225Ω (931AB and 931PB only)	2901-195149	38315	Type MS24T	1		
M1	E4-R3	Meter, 100-0-100 ua, 325Ω (931AB and 931PB only)	2901-208967	80145	Type 302	1		
W1	I3-Q2	Cable assy, probe	6002-230698	89536	6002-230698	1	1	
XDS1	C1-R2	Socket, lamp	2110-193037	95263	25-08-1	3		
XDS2	C1-S3	Socket, lamp	2110-193037	95263	25-08-1	REF		
XDS3	C1-Q1	Socket, lamp	2110-193037	95263	25-08-1	REF		
	J2-S3	Knob, CAL	2405-190249	89536	2405-190249	2		
	I3-R4	Knob, DIGIT	2405-158949	89536	2405-158949	4		
	I3-S3	Knob, DIGIT	2405-158949	89536	2405-158949	REF		
	I3-T1	Knob, DIGIT	2405-158949	89536	2405-158949	REF		
	I3-T5	Knob, DIGIT	2405-158949	89536	2405-158949	REF		
	J3-T2	Knob, MODE	2405-158956	89536	2405-158956	3		
	K2-T4	Knob, POWER	2405-158956	89536	2405-158956	REF		
	J3-R4	Knob, RANGE	2405-158956	89536	2405-158956	REF		
	J3-R1	*Panel decal (931A only)	1406-197665	89536	1406-197665	1		
	J3-R1	*Panel decal (931AB only)	1406-198085	89536	1406-198085	1		
	J3-R1	*Panel decal (931P only)	1406-221374	89536	1406-221374	1		
	J3-R1	*Panel decal (931PB only)	1406-221424	89536	1406-221424	1		
	F4-N4	*Panel, finished	1406-197582	89536	1406-197582	1		
	H3-P2	Probe assy, less cable assy	2109-238808	89536	2109-238808	1		
		*When ordering a front panel for the instrument, both the finished panel and the panel decal applicable to that model must be ordered.						

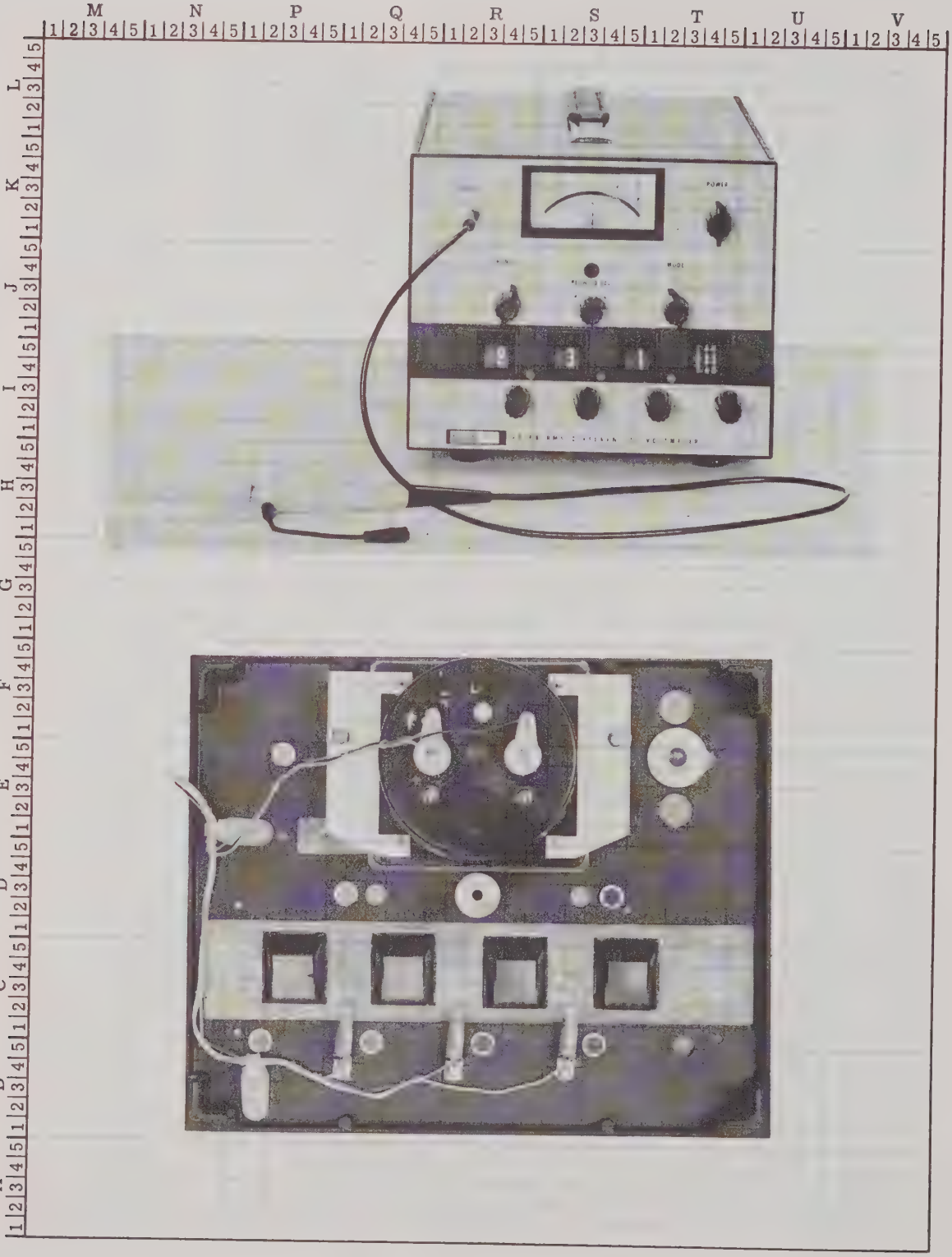


Figure 5-3. FRONT PANEL ASSEMBLY

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A3		**REAR PANEL ASSEMBLY** **Figure 5-4**						
F1		Fuse, Type AGL, fast act, 1/4 amp, 250v (for 115v operation) (not illustrated)	5105-109314	71400	Type AGL	1	5	
F1		Fuse, Type AGL, fast act, 1/8 amp, 250v (for 230v operation) (not illustrated)	5105-196790	71400	Type AGL	1	5	
P1	E1-J2	Connector, male, 3 contact, snap-in	2109-160275	73586	M-1548-GS	1		
R38	E1-L4	Res, var, comp, 2.5k ±20%, 1/2w	4701-192112	71450	VF-45	1		
J2	E3-M1	Binding post, black	2811-142984	58474	DF31BC	1		
J3	D5-M1	Binding post, red	2811-142976	56474	DF31RC	1		
XF1	E1-I4	Holder, fuse	2102-160846	75915	342004	1		
		Knob, RECORDER OUTPUT (not illustrated)	2405-190249	89536	2405-190249	REF		

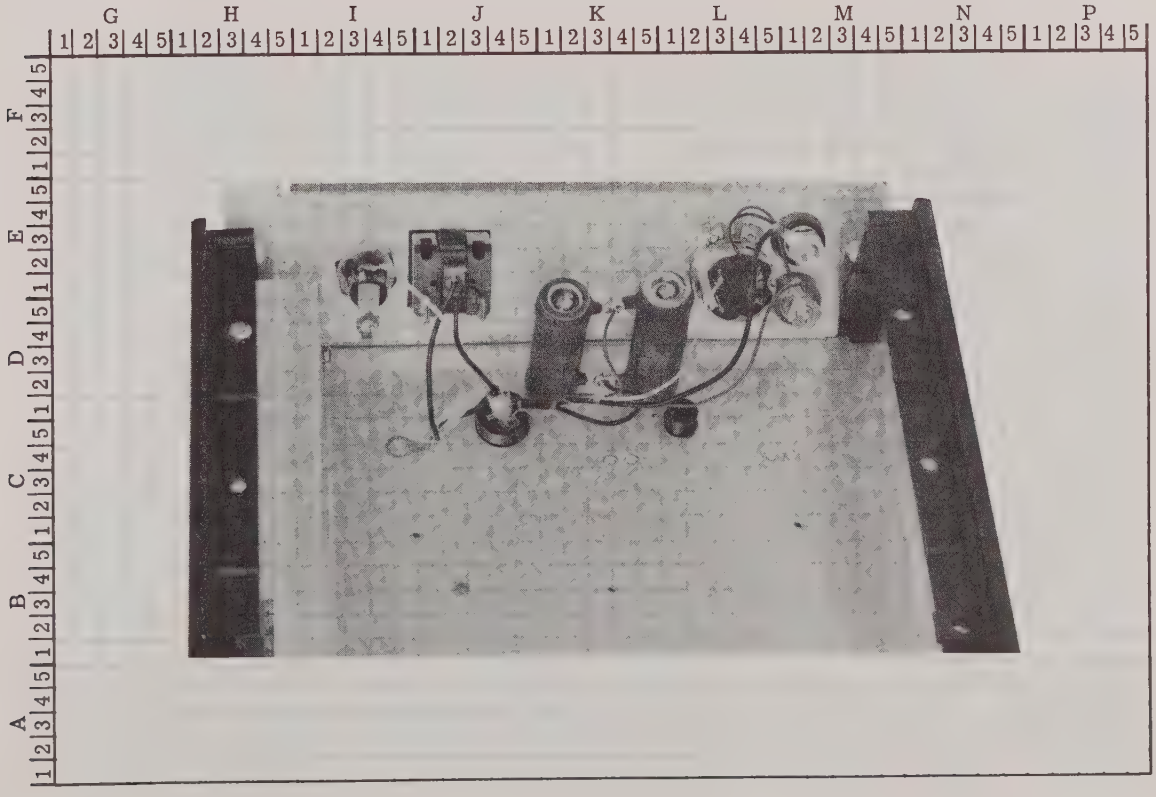


Figure 5-4. REAR PANEL ASSEMBLY

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A4		**SWITCH PANEL ASSEMBLY** **Figure 5-5**						
		(931A and 931P Line-powered models)	3158-197863 (931A-408)	89536	3158-197863	REF		
		(931AB and 931PB Battery/Line-powered models)	3158-198119 (931AB-402)	89536	3158-198119	REF		
A4A1	D2-Q1	Digit Switch Assembly (See Figure 5-6)	5110-197848 (931A-406)	89536	5110-197848	1		
A4A2	F1-T1	Mode Switch Assembly (See Figure 5-7)	5110-197855 (931A-407)	89536	5110-197855	1		
C1	G4-P1	Cap, matched pair, cer, 5.1 pf ±.25 pf, 500v (931A and 931AB only) (behind cover)	1501-199687	95275	VY10CA5-R1CA	1		
R1	G4-P1	Res, met flm, matched set (931A and 931AB only) (behind cover)	1					
R7	F5-R4	Res, var, comp, 5k ±20%, 1/2w	4701-195248	71450	VA-45	1		
R39	H3-U1	Res, comp, 39k ±5%, 1/4w (931AB and 931PB only)	4704-188466	01121	CB3935	1		
S1	G5-T4	Switch, POWER, rotary, 2p, 2 pos, 1 sect (931A and 931P only)	5105-180679	89536	5105-180679	1		
S1	G5-T4	Switch, POWER, rotary, 2p, 2 pos, 1 sect (931AB and 931PB only)	5105-198358	89536	5105-198358	1		
S3	F4-S4	Switch, CAL, leaf spring, 4p, spst, 2p, spdt	5106-198317	89536	5106-198317	1		

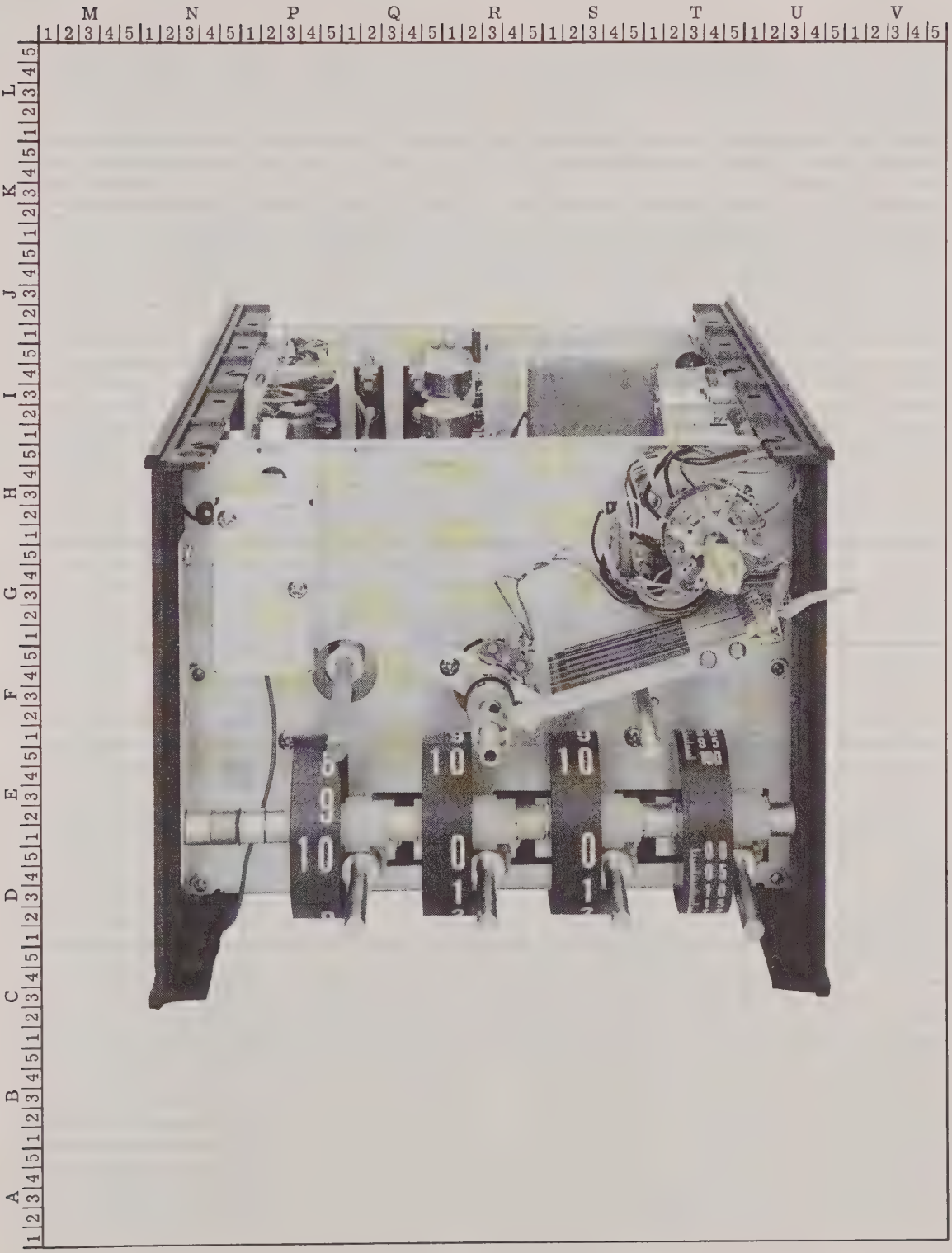


Figure 5-5. SWITCH PANEL ASSEMBLY

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A4A1		**DIGIT SWITCH ASSEMBLY** **Figure 5-6**	5110-197848 (931A-406)	89536	5110-197848	REF		
R11	I3-Q2	Res, ww, matched set	2					
R12	I3-Q4	Res, ww, matched set	2					
R13	H5-Q1	Res, met flm, 1k ±1%, 1/8w	4705-168229	12400	Type CEA T-O	3		
R14	H2-Q5	Res, ww, matched set	2					
R15	H2-P5	Res, met flm, 332Ω ±1%, 1/8w	4705-192898	12400	Type CEA T-O	1		
R16	H1-Q2	Res, ww, matched set	2					
R17		Res, met flm, 143Ω ±1%, 1/8w (not illustrated)	4705-192906	12400	Type CEA T-O	1		
R18	H4-Q1	Res, met flm, 1k ±1%, 1/8w	4705-168229	12400	Type CEA T-O	REF		
R19		Res, met flm, 1k ±1%, 1/8w (not illustrated)	4705-168229	12400	Type CEA T-O	REF		
R20	G5-Q5	Res, ww, matched set	2					
R21	G4-Q2	Res, comp, 10k ±5%, 1/4w	4704-148106	01121	CB1035	4		
R22	F5-R1	Res, ww, matched set	2					
R23	G3-Q2	Res, comp, 5.1k ±5%, 1/4w	4704-193342	01121	CB5125	1		
R24	F3-Q4	Res, ww, matched set	2					
R25	F4-Q1	Res, comp, 2.4k ±5%, 1/4w	4704-193433	01121	CB2425	1		
R26	F3-Q2	Res, ww, matched set	2					
R27		Res, comp, 1.2k ±5%, 1/4w (not illustrated)	4704-190371	01121	CB1225	4		
R28		Res, met flm, 1M ±.5%, 1/4w (not illustrated)	4705-198234	12400	Type CEB	1	1	
R29	F1-Q2	Res, comp, 100k ±5%, 1/4w	4704-148189	01121	CB1045	2		
R30	E5-R1	Res, met flm, 500k ±.25%, 1/4w	4705-198242	12400	Type CEB	1	1	
R31	E5-Q2	Res, comp, 51k ±5%, 1/4w	4704-193334	01121	CB5135	1		
R32	E2-Q5	Res, met flm, 250k ±1%, 1/4w	4705-198226	12400	Type CEB	1	1	
R33	E1-Q1	Res, comp, 24k ±5%, 1/4w	4704-193425	01121	CB2435	1		
R34		Res, met flm, 125k ±1%, 1/4w (not illustrated)	4705-198218	12400	Type CEB	1	1	
R35		Res, comp, 12k ±5%, 1/4w (not illustrated)	4704-159731	01121	CB1235	3		
R36	E1-Q4	Res, met flm, 49.9k ±1%, 1/2w	4705-182980	12400	Type CEC-TO	1		

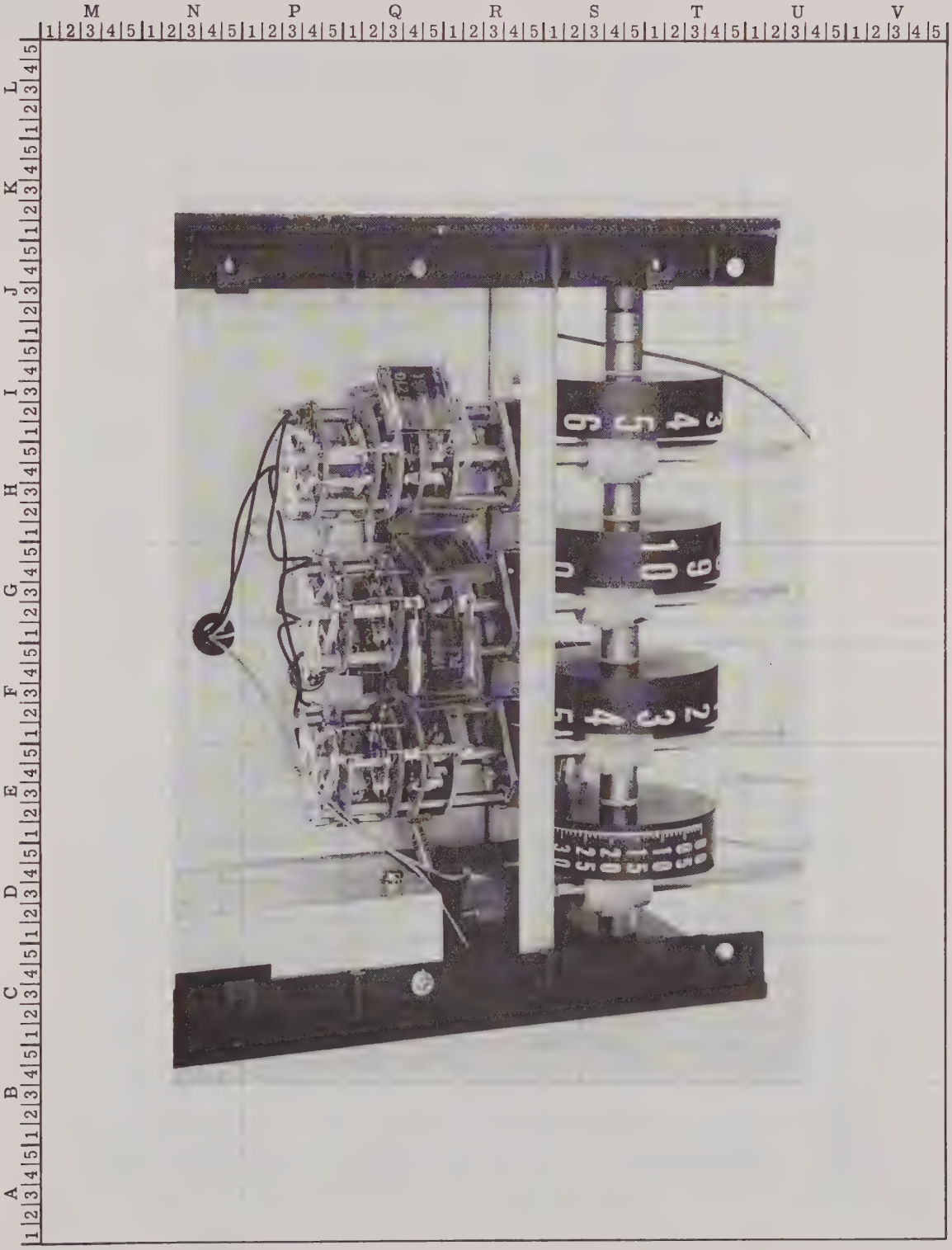


Figure 5-6. DIGIT SWITCH ASSEMBLY

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R37	D3-R3	Res, var, ww, 250Ω ±5%, 1w, 4th DIGIT	4711-197905	89536	4711-197905	1		
S4	H5-P4	Switch, 1st DIGIT, rotary, 11 pos, 5 sect	5105-198366	89536	5105-198366	1		
S5	G2-P5	Switch, 2nd DIGIT, rotary, 10 pos, 4 sect	5105-198325	89536	5105-198325	2		
S6	E5-P5	Switch, 3rd DIGIT, rotary, 10 pos, 4 sect	5105-198325	89536	5105-198325	REF		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A4A2		**MODE SWITCH ASSEMBLY** Figure 5-7	5110-197855 (931A-407)	89536	5110-197855	REF		
C2	C4-K1	Cap, cer, .5 pf ±.25 pf, 500v	1501-174896	71590	Type TC2	1		
C3	D4-K1	Cap, cer, 1 pf ±.25 pf, 600v	1501-105908	72982	331-000/ COKO/109C	1		
C4		Cap, mica, 33 pf ±5%, 500v (not illustrated)	1504-160317	04062	DM-15-330	3		
CR1	D3-H4	Diode, Type 1N4817	4802-116111	05277	1N4817	6		
R2	C4-K1	Res, met flm, matched set	▷3◁					
R3	C3-K1	Res, met flm, matched set	▷3◁					
R4	C5-K2	Res, comp, 470Ω ±5%, 1/4w	4704-147983	01121	CB4715	6		
R5	C3-K1	Res, met flm, matched set (not illustrated)	▷3◁					
R6	C5-K2	Res, comp, 110Ω ±5%, 1/4w	4704-193474	01121	CB1115	1		
R10	D4-H4	Res, comp, 2.2k ±5%, 1/4w	4704-148049	01121	CB2225	1		
S2	D2-K3	Switch, MODE, rotary, 8 pos	5105-198333	89536	5105-198333	1		

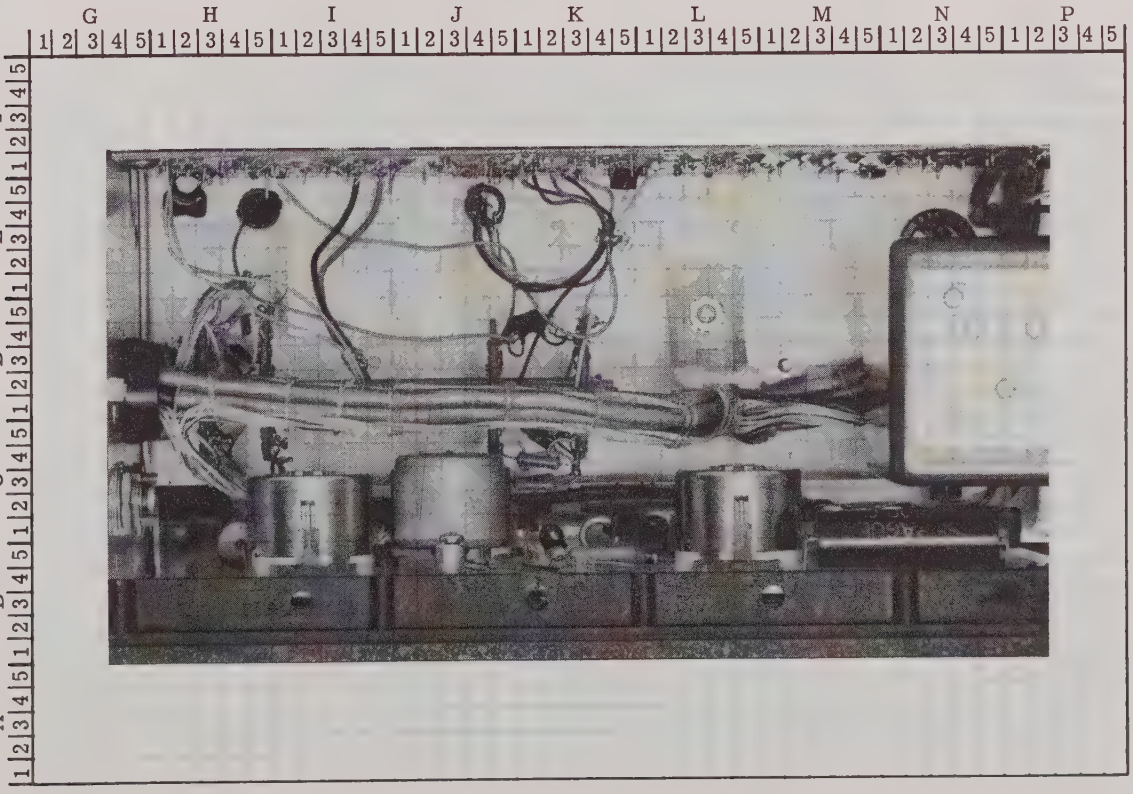


Figure 5-7. MODE SWITCH ASSEMBLY

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A5		**INPUT AMPLIFIER AND POWER SUPPLY ASSEMBLY -Figure 5-8**	1702-197798 (931A-401)	89536	1702-197798	REF		
C101	K3-S3	Cap, mylar, .47 uf ±20%, 600v	1507-105494	84411	JF-25	1		
C102	K1-S1	Cap, mica, 22 pf ±5%, 500v	1504-148551	04062	DM-15-220	2		
C103	J1-S2	Cap, poly, 0.1 uf ±20%, 250v	1507-161992	73445	C280AE/ P100K	1		
C104	I5-R5	Cap, mica, 33 pf ±5%, 500v	1504-160317	04062	DM-15-330	REF		
C105	I3-R5	Cap, Ta, 10 uf ±20%, 15v	1508-193623	06751	TSD2-15-106	4		
C106	I4-R4	Cap, mica, 27 pf ±5%, 500v	1504-177998	04062	DM-15-270	1		C, E
		Cap, mica, 39 pf ±5%, 500v (sheet 2 of 2)	1504-148544	04062	DM-15-390	3		D, F
C107	I2-R4	Cap, mica, 22 pf ±5%, 500v	1504-148551	04062	DM-15-220	REF		
C108	H2-S3	Cap, var, .5-3 pf, 1,000v	1509-195982	73899	ST851	1		
C109	H4-S1	Cap, mica, 39 pf ±5%, 500v	1504-148544	04062	DM-15-390	REF		
C110	H5-T2	Cap, Ta, 10 uf ±20%, 15v	1508-193623	06751	TSD2-15-106	REF		
C111	J2-S1	Cap, mica, 12 pf ±5%, 500v	1504-175224	04062	DM-15-120	1		C, E
		Cap, mica, 27 pf ±5%, 500v (sheet 2 of 2)	1504-177998	04062	DM-15-270	1		D, F
C112	G4-R5	Cap, Ta, 10 uf ±20%, 15v	1508-193623	06751	TSD2-15-106	REF		
C113	G5-R3	Cap, mica, 15 pf ±5%, 500v	1504-148569	04062	DM-15-150	1		
C114	I5-P4	Cap, cer, 22 pf ±5%, 50v	1501-217901	00656	C1-2	1		
C115	I2-P3	Cap, var, .8-10 pf , 250v	1509-193912	91293	JMC2950	2		
C116	I3-Q2	Cap, cer, 2,200 pf ±5%, 50v (sheet 2 of 2)	1501-217927	00656	MC605A22J	1		
C117	C4-T4	Cap, var, 4.5-25 pf, 500v (sheet 2 of 2)	1509-16 7007	72982	503-001	1		
C118	C4-S3	Cap, factory selected (sheet 2 of 2)						
C119	J4-P2	Cap, .8-10 pf, 250v	1509-193912	91293	JMC2950	REF		
C120		Cap, cer, 240 pf ±2%, 50v	1501-209551	95275	VY10CA241-GA	1		H
		Cap, cer, 220 pf ±5%, 50v (not illustrated)	1501-217919	00656	MC505A221J	1		B, I
C121	C1-T4	Cap, var, 4.5-25 pf, 500v	1509-167007	72982	503-001	1		H
		Cap, var, 1.5-7 pf, 500v (sheet 2 of 2)	1509-105973	72982	503NP01.5-7MMF	1		B, I
C122	B4-S1	Cap, elect, 400 uf +50/-10%, 25v	1502-168153	73445	C437ARF400	7	1	
C123	C4-T1	Cap, elect, 400 uf +50/-10%, 25v	1502-168153	73445	C437ARF400	REF		
C124	B4-Q3	Cap, elect, 400 uf +50/-10%, 25v	1502-168153	73445	C437ARF400	REF		

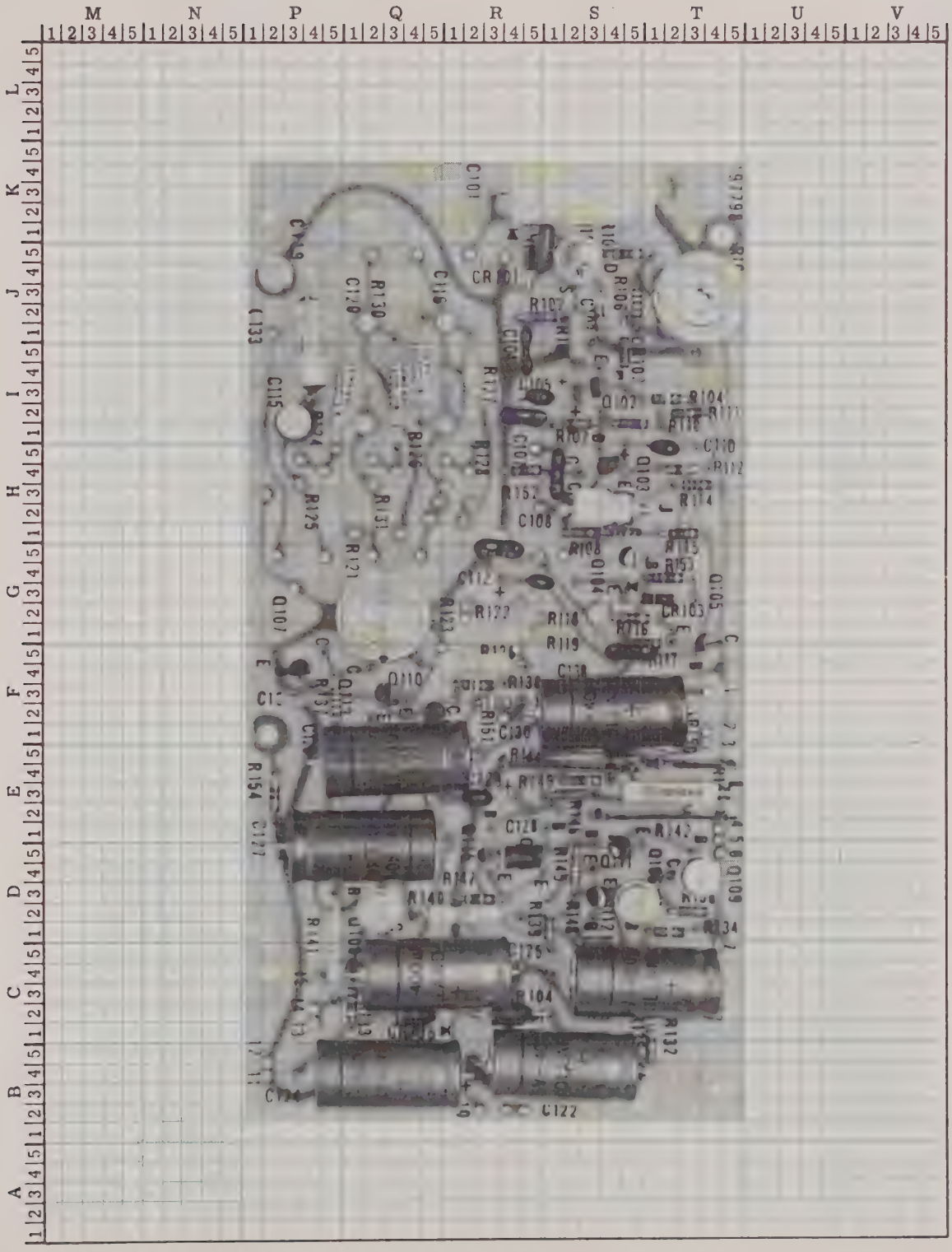


Figure 5-8. INPUT AMPLIFIER AND POWER SUPPLY ASSEMBLY (Sheet 1 of 2)

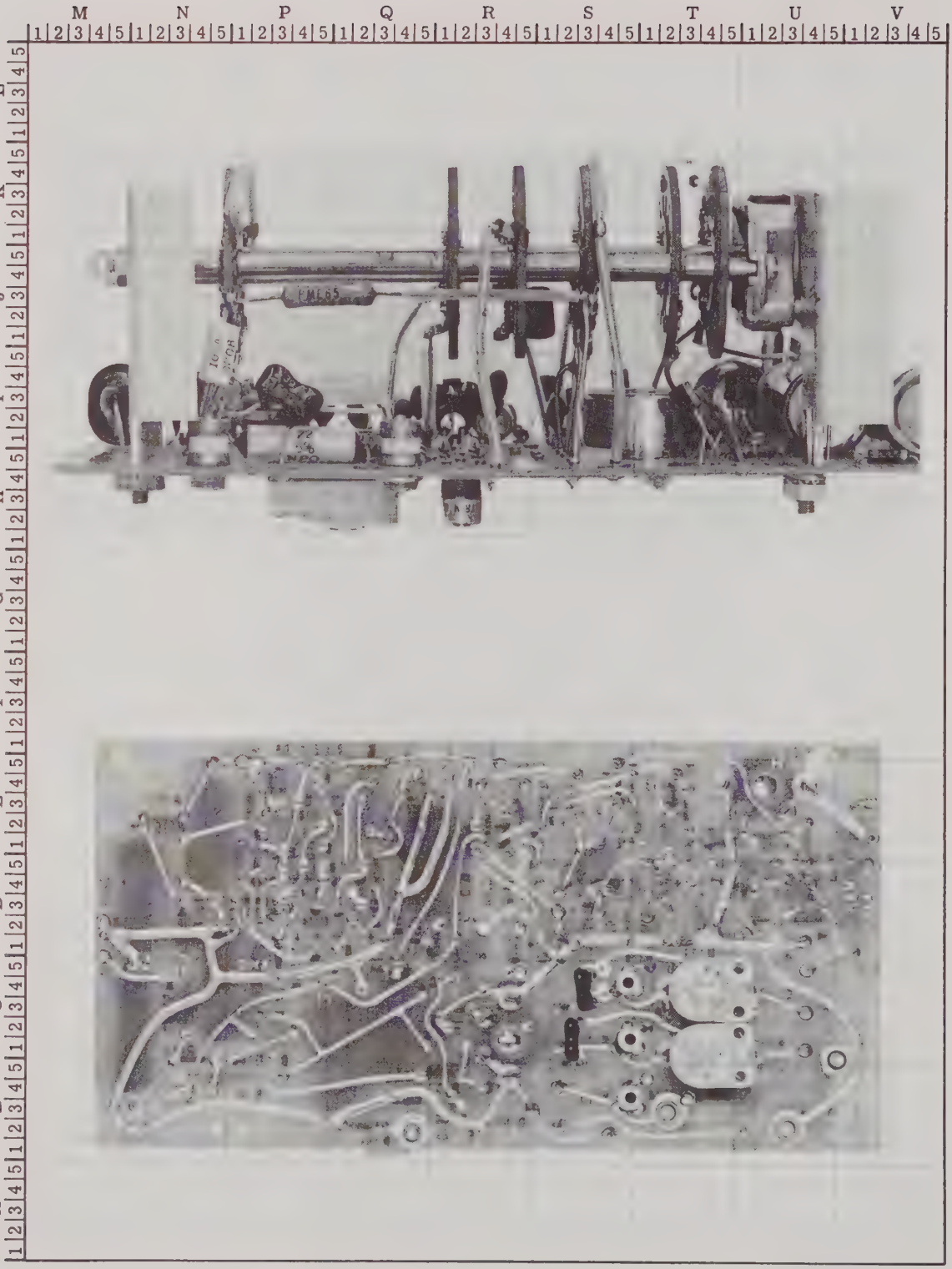


Figure 5-8. INPUT AMPLIFIER AND POWER SUPPLY ASSEMBLY (Sheet 2 of 2)

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
C125	C4-Q5	Cap, elect, 400 uf +50/-10%, 25v	1502-168153	73445	C437ARF400	REF		
C126	E5-Q3	Cap, elect, 400 uf +50/-10%, 25v	1502-168153	73445	C437ARF400	REF		
C127	D5-Q2	Cap, elect, 400 uf +50/-10%, 25v	1502-168153	73445	C437ARF400	REF		
C128	E2-R5	Cap, cer, 0.01 uf ±20%, 50v	1501-149153	56289	19C214A6	2		
C129	E3-R2	Cap, Ta, 10 uf ±20%, 15v	1508-193623	06751	TSD2-15-106	REF		
C130	F2-S4	Cap, elect, 400 uf +50/-10%, 25v	1502-168153	73445	C437ARF400	REF		
C131	F3-P3	Cap, cer, 0.01 uf ±20%, 50v	1501-149153	56289	19C214A6	REF		
C132	I5-N5	Cap, cer, 3 pf ±0.1%, 50v (sheet 2 of 2)	1501-209577	84411	Type 663UW	1		
C133	I4-P3	Cap, mica, 39 pf ±5%, 500v (sheet 2 of 2)	1504-148544	04062	DM-15-390	REF		
C134	C5-S4	Cap, factory selected (sheet 2 of 2) (not illustrated)	4					
C135		Cap, poly, 0.1 uf ±20%, 250v (not illustrated)	1507-161992	73445	C280AE/ P100K	2		L
C136		Cap, poly, 0.1 uf ±20%, 250v (not illustrated)	1507-161992	73445	C280AE/ P100K	REF		L
C137		Cap, mica, 68 pf ±5%, 500v (not illustrated)	1504-148510	04062	DM-15-680	1		G
C138	F5-S5	Cap, mica, 10 pf ±10%, 500v	1504-175216	04062	DM-15-100	1		
C139	C1-S2	Cap, factory selected (sheet 2 of 2)	4					
CR101	J5-R5	Diode, Transistron Type SG5658	4802-161810	03877	SG5658	1	1	
CR102	I5-S4	Diode, Transistron Type SG22	4802-113308	03877	SG22	1	1	
CR103	G3-T1	Diode, zener, 9.4v, Type 1N758	4803-180406	07910	1N758	1	1	
CR104	C2-R4	Diode, Type 1N4817	4802-116111	05277	1N4817	REF	2	
CR105	C2-Q4	Diode, Type 1N4817	4802-116111	05277	1N4817	REF		
CR106	E5-S4	Diode, zener, matched set	5					
Q101	J5-S3	Tstr, Siliconix Type FN-323	4805-192864	16856	FN-323	1	1	
Q102	I3-S3	Tstr, Type 2N3906	4805-195974	04713	2N3906	3	1	
Q103	H5-S4	Tstr, Motorola Type MPS6520	4805-218081	04713	MPS6520	6	2	
Q104	G5-S5	Tstr, Motorola Type MPS6520	4805-218081	04713	MPS6520	REF		
Q105	G1-T4	Tstr, Motorola Type MPS6520	4805-218081	04713	MPS6520	REF		
Q106	D2-S5	Tstr, Type 2N1304	4805-117127	95303	2N1304	1	1	
Q107	F4-P3	Tstr, Motorola Type MPS3638	4805-169375	04713	MPS3638	2	1	

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
Q108	D2-Q2	Tstr, Type 2N3945	4805-203489	03877	2N3945	3	1	
Q109	D4-T3	Tstr, Motorola Type SM4144	4805-190389	04713	SM4144	1	1	
Q110	F3-Q3	Tstr, Type 2N3906	4805-195974	04713	2N3906	REF		
Q111	D5-S4	Tstr, Type 2N3391	4805-168708	03508	2N3391	12	4	
Q112	D3-S3	Tstr, Type 2N3391	4805-168708	03508	2N3391	REF		
Q113	F2-Q5	Tstr, Motorola Type MPS3638	4805-169375	04713	MPS3638	REF		
Q114, Q115	D5-R5	Tstr, Type 2N3391, matched pair	4805-235820	89536	4805-235820	2	1	
R101	J5-S5	Res, comp, 1k ±5%, 1/4w	4704-148023	01121	CB1025	2		
R102	J2-R5	Res, comp, 150Ω ±5%, 1/4w	4704-147934	01121	CB1515	1		
R103	J2-S3	Res, comp, 47Ω ±5%, 1/4w	4704-147892	01121	CB4705	1		
R104	I3-T2	Res, comp, 120k ±5%, 1/4w	4704-193458	01121	CB1245	2		
R105	J4-T3	Res, var, ww, 10k ±20%, 1-1/4w	4702-112862	71450	Type 110	2		
R106	J3-S5	Res, comp, 47k ±5%, 1/4w	4704-148163	01121	CB4735	3		
R107	I2-S2	Res, comp, 100Ω ±5%, 1/4w	4704-147926	01121	CB1015	3		
R108	H1-S3	Res, comp, 2.7M ±5%, 1/4w	4704-193490	01121	CB2755	1		
R109	I4-Q5	Res, comp, 33Ω ±5%, 1/4w (sheet 2 of 2)	4704-175034	01121	CB3305	3		
R110	I2-S5	Res, comp. 2.7k ±5%, 1/4w	4704-170720	01121	CB2725	2		
R111	I2-T3	Res, comp, 5.6k ±5%, 1/4w	4704-148080	01121	CB5625	2		
R112	H4-T2	Res, comp, 10k ±5%, 1/4w	4704-148106	01121	CB1035	REF		
R113	J2-R4	Res, comp, 220k ±5%, 1/4w Res, comp, 100k ±5%, 1/4w (sheet 2 of 2)	4704-160937 4704-148189	01121 01121	CB2245 CB1045	1 REF		C, E D, F
R114	H3-T3	Res, comp, 8.2k ±5%, 1/4w	4704-160796	01121	CB8225	5		
R115	H1-T2	Res, comp, 100Ω ±5%, 1/4w	4704-147926	01121	CB1015	REF		
R116	G2-S5	Res, comp, 10Ω ±5%, 1/4w	4704-147868	01121	CB1005	3		
R117	G1-T1	Res, comp, 2.7k ±5%, 1/4w	4704-170720	01121	CB2725	REF		
R118		Res, ww (not illustrated)	2					
R119		Res, ww (not illustrated)	2					
R120	F5-R3	Res, met flm, 26.1k ±1%, 1/2w	4705-208371	12400	Type CEC-TO	1		
R121	G3-Q2	Res, var, ww, 10k ±20%, 1-1/4w	4702-112862	71450	Type 110	REF		
R122		Res, ww (not illustrated)	2					
R123		Res, ww (not illustrated)	2					

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R124	I3-P5	Res, met flm, matched set	1					
R125	B4-S5	Res, var, comp, 1k ±30%, 1/2w (sheet 2 of 2)	4701-193060	73138	62P-RIK	1		
R126	I4-Q4	Res, met flm, matched set	1					
R127	I4-R2	Res, met flm, 40.2k ±1%, 1/2w	4705-161059	12400	Type CEC-TO	1		
R128	C4-S5	Res, var, comp, 100k ±30%, 1/2w (sheet 2 of 2)	4701-193045	73138	62P-R100K	1		
R129	J3-P5	Res, met flm, matched set (sheet 2 of 2)	1					
R130	I4-Q3	Res, met flm, matched set	1					
R131	C2-S5	Res, var, comp, 100Ω ±30%, 1/2w	4701-193052	73138	62P-R100	1		
R132	C1-T1	Res, comp, 33Ω ±5%, 1/4w	4704-175034	01121	CB3305	REF		
R133	C2-Q1	Res, comp, 33Ω ±5%, 1/4w	4704-175034	01121	CB3305	REF		
R134	D1-T2	Res, comp, 27k ±5%, 1/4w	4704-148148	01121	CB2735	4		
R135	C2-S3	Res, comp, 33k ±5%, 1/4w	4704-148155	01121	CB3335	3		
R136	D2-T3	Res, comp, 220Ω ±5%, 1/4w	4704-147959	01121	CB2215	2		
R137	F3-P5	Res, comp, 18k ±5%, 1/4w	4704-148122	01121	CB1835	2		
R138	F3-R2	Res, comp, 180k ±5%, 1/4w	4704-193441	01121	CB1845	3		
R139	D1-S1	Res, comp, 3k ±5%, 1/4w	4704-193508	01121	CB3025	1		
R140	D2-R2	Res, met flm, 75k ±1%, 1/4w	4705-103961	12400	Type CEC-TO	1		
R141	D1-P5	Res, met flm, 68.1k ±1%, 1/2w	4705-161083	12400	Type CEC-TO	1		
R142	E2-T2	Res, ww, 20k,1w	4707-131680	89536	4707-131680	1		
R143	E3-T2	Res, var, ww, 2k ±10%, 1w	4702-190355	02660	Type 2610	1		
R144	E4-S4	Res, ww, 15.6k	4707-195826	89536	4707-195826	1	1	
R145	D4-S2	Res, comp, 56k ±5%, 1/4w	4704-170738	01121	CB5635	2		
R146	E3-S2	Res, comp, 820Ω ±5%, 1/4w	4704-148015	01121	CB8215	1		
R147	D3-R2	Res, comp, 30k ±5%, 1/4w	4704-193417	01121	CB3035	1		
R148	D1-S3	Res, comp, 56k ±5%, 1/4w	4704-170738	01121	CB5635	REF		
R149	E4-S3	Res, comp, 10k ±5%, 1/4w	4704-148106	01121	CB1035	REF		
R150	E4-T4	Res, ww, matched set	5					
R151	F2-R3	Res, comp, 330Ω ±5%, 1/4w	4704-147967	01121	CB3315	2		
R152	H4-R5	Res, comp, 100Ω ±5%, 1/4w	4704-147926	01121	CB1015	REF		
R153	G4-T2	Res, comp, 22Ω ±5%, 1/4w	4704-147884	01121	CB2205	1		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R154	E3-P2	Res, comp, 10Ω ±5%, 1/4w	4704-147868	01121	CB1005	REF		
S101	J5-T2	Switch, RANGE, rotary, 5 pos, 6 sect	5105-198341	89536	5105-198341	1		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A6		**VARIABLE GAIN AC AMPLIFIER ASSEMBLY - Figure 5-9**	1702-197806 (931A-402)	89536	1702-197806	REF		
C201	E2-R5	Cap, elect, 80 uf +50/-10%, 16v	1502-192914	73445	C426ARE80	6	1	
C202	D4-R5	Cap, elect, 80 uf +50/-10%, 16v	1502-192914	73445	C426ARE80	REF		
C203	G2-Q3	Cap, cer, .05 uf +80/-20%, 500v	1501-105676	56289	33C58B	2		
C204	F3-R2	Cap, mica, 100 pf ±5%, 500v	1504-148494	04062	DM-15-101	2		
C205	F5-R5	Cap, Ta, 5.6 uf ±10%, 35v	1508-198259	05397	K5R6C35K	1		
C206	F2-Q5	Cap, mica, 5 pf ±10%, 500v	1504-148577	04062	DM-15-050	1		
C207	F3-Q3	Cap, var, 1-8 pf, 1,000v	1509-195990	73899	ST853	1		
C208	G3-R3	Cap, elect, 1,250 uf +50/-10%, 4v	1502-166330	73445	C437ARB1250	1	1	
C209	G4-Q1	Cap, elect, 80 uf +50/-10%, 16v	1502-192914	73445	C426ARE80	REF		
C210	H3-Q5	Cap, cer, .05 uf +80/-20%, 500v	1501-105676	56289	33C58B	REF		
C211	I1-Q2	Cap, elect, 80 uf +50/-10%, 16v	1502-192914	73445	C426ARE80	REF		
C212	I1-Q4	Cap, elect, 80 uf +50/-10%, 16v	1502-192914	73445	C426ARE80	REF		
C213	K1-R2	Cap, Ta, 68 uf ±10%, 15v	1508-182824	05397	K68C15K	2		
C214	J4-R1	Cap, Ta, 68 uf ±10%, 15v	1508-182824	05397	K68C15K	REF		
C215	I1-R3	Cap, Ta, 330 uf ±10%, 6v	1508-193011	05397	K330J6K	2		
C216	I1-R5	Cap, Ta, 330 uf ±10%, 6v	1508-193011	05397	K330J6K	REF		
C217	H1-S2	Cap, factory selected	④					
C218	J3-T2	Cap, factory selected	④					
C219	J5-S3	Cap, factory selected	④					
C220	E3-R4	Cap, mica, 33 pf ±5%, 500v	1504-160317	04062	DM-15-330	REF		
CR201	B4-S4	Diode, Type 1N4817	4802-116111	05277	1N4817	REF		
CR202	B5-S4	Diode, Type 1N4817	4802-116111	05277	1N4817	REF		
K201	K2-S2	Reed switch assy Relay, 115 vac, dpdt	5110-197889 4504-218073	89536 24446	5110-197889 3SBF-5-43-4-M-1	1 1	1 1	M, O N, P
Q201	E4-R3	Tstr, Cont Device Type CS23030 Tstr, Motorola Type MPS6520	4805-159855 4805-218081	07910 04713	CS23030 MPS6520	3 REF	1	M, O N, P
Q202	E5-Q3	Tstr, Cont. Device Type CS23030 Tstr, Motorola Type MPS6520	4805-159855 4805-218081	07910 04713	CS23030 MPS6520	REF REF		M, O N, P
Q203	F5-Q5	Tstr, Cont Device Type CS23030 Tstr, Motorola Type MPS6520	4805-159855 4805-218081	07910 04713	CS23030 MPS6520	REF REF		M, O N, P
Q204	H1-Q3	Tstr, Cont Device Type CS23030	4805-159855	07910	CS23030	2	1	

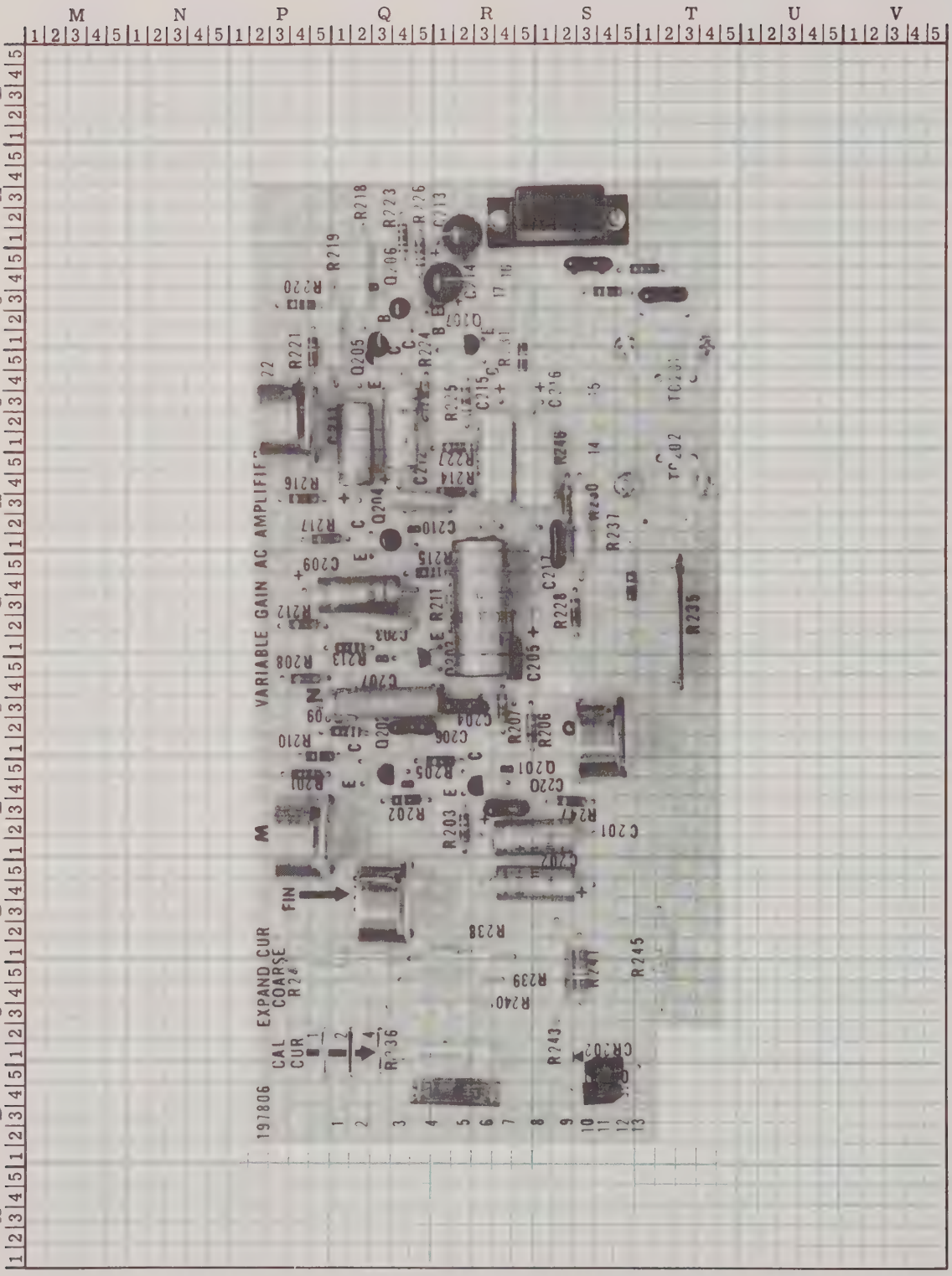


Figure 5-9. VARIABLE GAIN AC AMPLIFIER ASSEMBLY

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
Q205	J1-Q3	Tstr, Type 2N3391	4805-168708	03508	2N3391	REF		
Q206	J3-Q4	Tstr, Cont Device Type CS23030	4805-159855	07910	CS23030	REF		
Q207	J1-R2	Tstr, Type 2N3906	4805-195974	04713	2N3906	REF		
R201	E5-P4	Res, comp, 1.2k ±5%, 1/4w	4704-190371	01121	CB1225	REF		
R202	E3-Q4	Res, comp, 12k ±5%, 1/4w	4704-159731	01121	CB1235	REF		
R203	E2-R2	Res, comp, 10k ±5%, 1/4w	4704-148106	01121	CB1035	REF		
R204	E1-P4	Res, var, ww, 3k ±20%, 1-1/4w	4702-149781	71450	Type 110	1		
R205	E5-R1	Res, comp, 200Ω ±5%, 1/4w	4704-193482	01121	CB2015	2		
R206	F2-R5	Res, comp, 200Ω ±5%, 1/4w	4704-193482	01121	CB2015	REF		
R207	F3-R4	Res, factory selected	▷4					
R208	F4-P4	Res, comp, 8.2k ±5%, 1/4w	4704-160796	01121	CB8225	REF		
R209	F2-Q1	Res, comp, 470Ω ±5%, 1/4w	4704-147983	01121	CB4715	REF		
R210	F1-P5	Res, comp, 15k ±5%, 1/4w	4704-148114	01121	CB1535	5		
R211	G3-R1	Res, comp, 33k ±5%, 1/4w	4704-148155	01121	CB3335	REF		
R212	G2-P4	Res, comp, 8.2k ±5%, 1/4w	4704-160796	01121	CB8225	REF		
R213	G1-Q1	Res, comp, 3.3k ±5%, 1/4w	4704-148056	01121	CB3325	2		
R214	H4-R1	Res, comp, 1.5k ±5%, 1/4w	4704-148031	01121	CB1525	3		
R215	G5-Q5	Res, comp, 43k ±5%, 1/4w	4704-193367	01121	CB4335	1		
R216	H3-P4	Res, comp, 1.5k ±5%, 1/4w	4704-148031	01121	CB1525	REF		
R217	H1-P5	Res, comp, 8.2k ±5%, 1/4w	4704-160796	01121	CB8225	REF		
R218	J4-Q2	Res, met flm, 2.37k ±1%, 1/2w	4705-182519	12400	Type CEC-TO	1		
R219	J1-Q1	Res, met flm, 1.58k ±1%, 1/2w	4705-182543	12400	Type CEC-TO	1		
R220	J3-P4	Res, comp, 18k ±5%, 1/4w	4704-148122	01121	CB1835	REF		
R221	I5-P5	Res, comp, 15k ±5%, 1/4w	4704-148114	01121	CB1535	REF		
R222	I2-P3	Res, var, ww, 5k ±5%, 1-1/4w	4702-163709	71450	Type 110	1		
R223	K1-Q4	Res, comp, 4.3k ±5%, 1/4w	4704-193375	01121	CB4325	3		
R224	I3-Q5	Res, comp, 39Ω ±5%, 1/4w	4704-193391	01121	CB3905	REF		
R225	I3-R2	Res, comp, 39Ω ±5%, 1/4w	4704-193391	01121	CB3905	REF		
R226	J5-Q5	Res, comp, 4.3k ±5%, 1/4w	4704-193375	01121	CB4325	REF		
R227	I1-R2	Res, comp, 470Ω ±5%, 1/4w	4704-147983	01121	CB4715	REF		
R228	G3-S2	Res, comp, 1k ±5%, 1/4w	4704-148023	01121	CB1025	REF		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R229	F1-S4	Res, var, ww, 1k ±20%, 1-1/4w	4702-113266	71450	Type 110	1		
R230	H2-S3	Res, met flm, 4.02k ±1%, 1/2w	4705-167478	12400	Type CEC-TO	1		
R231	I5-R5	Res, ww, matched set	2					
R232	B4-R2	Res, ww, 3.2k ±1%	4707-195842	89536	4707-195842	1	1	
R233	J3-S4	Res, factory selected	4					
R234	J4-T1	Res, factory selected	4					
R235	G2-T3	Res, ww, 63.7k	4707-195818	89536	4707-195818	1	1	
R236	C1-R1	Res, var, ww, 10k ±10%, 1w	4702-190348	02660	Type 2610	1		
R237	G4-S5	Res, selected, matched zener reference set	5					
R238	D1-R2	Res, met flm, 15Ω ±1%, 1/2w	4705-151050	12400	Type CEC-TO	1		
R239	C5-R2	Res, met flm, 30.1Ω ±1%, 1/2w	4705-198291	12400	Type CEC-TO	1		
R240	C3-R1	Res, met flm, 60.4Ω ±1%, 1/2w	4705-196691	12400	Type CEC	1		
R241	C5-S3	Res, comp, 82k ±5%, 1/2w	4704-195966	01121	EB8235	1		
R242	D3-Q3	Res, var, ww, 10k ±10%, 1-1/4w	4702-162115	71450	Type 110	1		
R243	C5-S2	Res, met flm, 3.01k ±1%, 1/2w	4705-196709	12400	Type CEC	1		
R244	C5-P5	Res, var, ww, 1k ±10%, 1w	4702-190363	02660	Type 2610	1		
R245	D1-T2	Res, met flm, 19.6k ±1%, 1/2w	4705-159640	12400	Type CEC-TO	2		
R246	H3-S2	Res, factory selected	4					
R247	E3-S2	Res, comp, 10Ω ±5%, 1/4w	4704-147868	01121	CB1005	REF		
TC201 TC202	I4-T1	Thermocouple, vacuum, (matched pair)	5302-199679	11403	CS1707A	1	1	

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A7		**NULL DETECTOR ASSEMBLY** Figure 5-10	1702-197814 (931A-403)	89536	1702-197814	REF		
C301	J2-N5	Cap, poly, 0.1 uf ±10%, 50v	1507-150318	84411	194P1049R5	1		
C302	H5-R1	Cap, Ta, 39 uf ±20%, 6v	1508-163915	06751	TSD2-6-396	1		
C303	I5-S1	Cap, Ta, 15 uf ±20%, 6v	1508-161935	06751	TSD1-6-156	2		
C304	H2-U5	Cap, poly, 0.047 uf ±10%, 50v	1507-150300	84411	194P4739R5	2		
C305	G1-U3	Cap, poly, 0.047 uf ±20%, 250v	1507-162008	73445	C280AE/P47K	5		
C306	H1-U3	Cap, poly, 0.047 uf ±10%, 50v	1507-150300	84411	194P4739R5	REF		
C307	G4-T1	Cap, cer, 180 pf ±10%, 500v	1501-105890	71590	BB60181KS3N	1		
C308	I5-N1	Cap, poly, 0.047 uf ±20%, 250v	1507-162008	73445	C280AE/P47K	REF		
C309	I2-N2	Cap, Ta, 15 uf ±20%, 6v	1508-161935	06751	TSD1-6-156	REF		
C310	H3-Q1	Cap, poly, 0.047 uf ±20%, 250v	1507-162008	73445	C280AE/P47K	REF		
C311	G1-T2	Cap, poly, 0.047 uf ±20%, 250v	1507-162008	73445	C280AE/P47K	REF		
C312	F1-U5	Cap, Ta, 15 uf ±20%, 6v Cap, Ta, 6.8 uf ±10%, 35v	1508-161935 1508-182782	06751 05397	TSD1-6-156 K6R8C35K	1 1		C, E D, F
C313	F4-U4	Cap, elect, 80 uf +50/-10%, 16v	1502-192914	73445	C426ARE80	REF	1	
C314	E5-U2	Cap, poly, 0.047 uf ±20%, 250v	1507-162008	73445	C280AE/P47K	REF		
C315	F1-Q1	Cap, poly, 0.47 uf ±20%, 250v	1507-184366	73445	C280AE/ P470K	2		
C316	H2-Q1	Cap, Ta, 1 uf ±20%, 35v	1508-161919	06751	TSD1-35-105	1		
C317	G4-R3	Cap, Ta, 150 uf +20/-15%, 15v	1508-160945	56289	109D157C201-5TO	2		
C318	G1-R5	Cap, Ta, 150 uf +20/-15%, 15v	1508-160945	56289	109D157C201-5TO	REF		
C319	E1-Q4	Cap, poly, 0.47 uf ±20%, 250v	1507-184366	73445	C280AE/ P470K	REF		
CR301	I1-T3	Diode, Type 1N456A	4802-190272	93332	1N456A	1	1	
CR302	I4-R5	Diode, Type 1N279	4802-163907	93332	1N279	1	1	
CR303	E3-S4	Diode, Type 1N4817	4802-116111	05277	1N4817	REF		
L301	H2-S5	Transformer, resonator #2	5602-197962	89536	5602-197962	1		
Q301	I4-N5	Tstr, Type 2N3945	4805-203489	03877	2N3945	REF		
Q302	I4-P3	Tstr, Type 2N3945	4805-203489	03877	2N3945	REF		
Q303	I2-R3	Tstr, Type 2N3391	4805-168708	03508	2N3391	REF		
Q304	H4-S2	Tstr, Type 2N3391	4805-168708	03508	2N3391	REF		

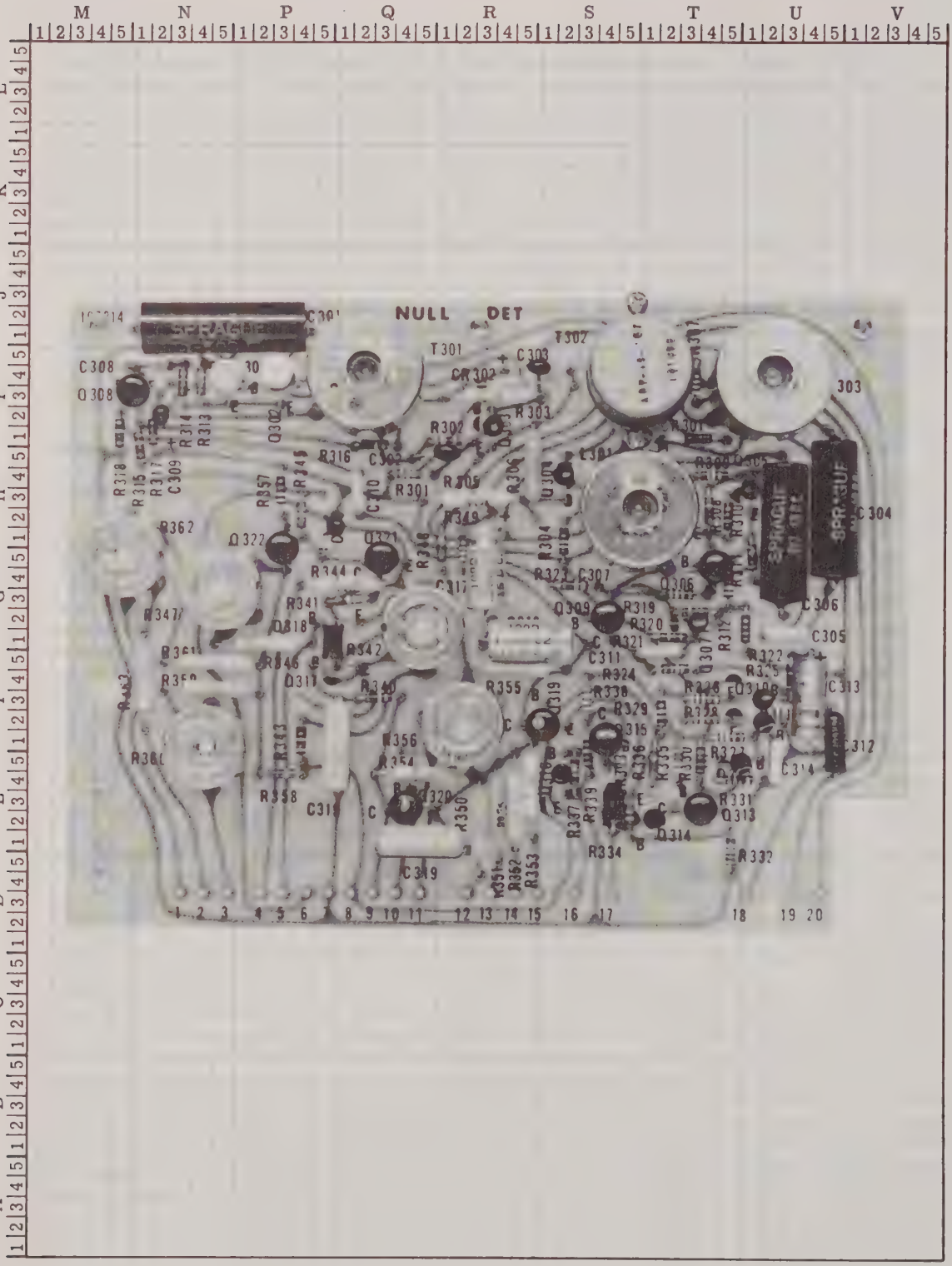


Figure 5-10. NULL DETECTOR ASSEMBLY

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
Q305	H4-U1	Tstr, Type 2N3391	4805-168708	03508	2N3391	REF		
Q306	G5-T4	Tstr, Type 2N3638	4805-203364	07263	2N3638	7	2	
Q307	G2-T4	Tstr, Type 2N3391	4805-168708	03508	2N3391	REF		
Q308	I3-N1	Tstr, Type 2N3638	4805-203364	07263	2N3638	REF		
Q309	G2-S4	Tstr, Type 2N3638	4805-203364	07263	2N3638	REF		
Q310	F3-U2	Tstr, Type 2N3391	4805-168708	03508	2N3391	REF		
Q311	F2-U2	Tstr, Type 2N3391	4805-168708	03508	2N3391	REF		
Q312	E5-U1	Tstr, Type 2N3391	4805-168708	03508	2N3391	REF		
Q313	E3-T4	Tstr, Type 2N3638	4805-203364	07263	2N3638	REF		
Q314	E2-T1	Tstr, Type 2N3391	4805-168708	03508	2N3391	REF		
Q315	F1-S4	Tstr, Type 2N3638	4805-203364	07263	2N3638	REF		
Q316	E4-S2	Tstr, Type 2N3391	4805-168708	03508	2N3391	REF		
Q317, Q318	G1-Q1	Tstr, Type 2N3391, pair	4805-235820	89536	4805-235820	REF		
Q319	F2-S1	Tstr, selected Type 2N3638	4805-193904	89536	4805-193904	2	1	
Q320	E3-Q4	Tstr, selected Type 2N3638	4805-193904	89536	4805-193904	REF		
Q321	G5-Q3	Tstr, Type 2N3638	4805-203364	07263	2N3638	REF		
Q322	H1-P3	Tstr, Type 2N3638	4805-203364	07263	2N3638	REF		
R301	H4-Q4	Res, comp, 330k ±5%, 1/4w	4704-192948	01121	CB3345	1		
R302	I1-R1	Res, comp, 39Ω ±5%, 1/4w	4704-193391	01121	CB3905	REF		
R303	I3-R4	Res, met flm, 22.1Ω ±1%, 1/2w	4705-151472	12400	Type CEC-TO	1		
R304	H1-S2	Res, comp, 180k ±5%, 1/4w	4704-193441	01121	CB1845	REF		
R305	H3-R3	Res, met flm, 825k ±1%, 1/2w	4705-151308	12400	Type CEC-TO	1		
R306	H5-R5	Res, met flm, 90.9k ±1%, 1/2w	4705-162974	12400	Type CEC-TO	1		
R307	I4-T3	Res, comp, 47k ±5%, 1/4w	4704-148163	01121	CB4735	REF		
R308	H2-T4	Res, comp, 1M ±5%, 1/4w	4704-182204	01121	CB1055	1		
R309	H4-T4	Res, comp, 180k ±5%, 1/4w	4704-193441	01121	CB1845	REF		
R310	H2-T5	Res, comp, 6.8k ±5%, 1/4w	4704-148098	01121	CB6825	3		
R311	G5-U1	Res, comp, 15Ω ±5%, 1/4w	4704-147876	01121	CB1505	2		
R312	G4-T5	Res, comp, 4.3k ±5%, 1/4w	4704-193375	01121	CB4325	REF		
R313	I4-N4	Res, comp, 220Ω ±5%, 1/4w	4704-147959	01121	CB2215	REF		
R314	I4-N3	Res, comp, 5.6k ±5%, 1/4w	4704-148080	01121	CB5625	REF		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R315	I1-N1	Res, comp, 15k ±5%, 1/4w	4704-148114	01121	CB1535	REF		
R316	I1-Q4	Res, comp, 120k ±5%, 1/4w	4704-193458	01121	CB1245	REF		
R317	I1-N2	Res, comp, 1.2k ±5%, 1/4w	4704-190371	01121	CB1225	REF		
R318	I1-M5	Res, comp, 15k ±5%, 1/4w	4704-148114	01121	CB1535	REF		
R319	G3-T3	Res, comp, 39k ±5%, 1/4w	4704-188466	01121	CB3935	1		
R320	G2-T3	Res, comp, 6.8k ±5%, 1/4w	4704-148098	01121	CB6825	REF		
R321	G1-T2	Res, comp, 6.8k ±5%, 1/4w	4704-148098	01121	CB6825	REF		
R322	G2-U1	Res, comp, 1.2k ±5%, 1/4w	4704-190371	01121	CB1225	REF		
R323	G4-S2	Res, comp, 15k ±5%, 1/4w	4704-148114	01121	CB1535	REF		
R324	F5-T2	Res, comp, 12k ±5%, 1/4w	4704-159731	01121	CB1235	REF		
R325	F4-U3	Res, comp, 15Ω ±5%, 1/4w	4704-147876	01121	CB1505	REF		
R326	F3-T4	Res, comp, 470Ω ±5%, 1/4w	4704-147983	01121	CB4715	REF		
R327	F1-T5	Res, comp, 47k ±5%, 1/4w	4704-148163	01121	CB4735	REF		
R328	F2-T4	Res, comp, 470Ω ±5%, 1/4w	4704-147983	01121	CB4715	REF		
R329	F3-T2	Res, comp, 27k ±5%, 1/4w	4704-148148	01121	CB2735	REF		
R330	E5-T4	Res, comp, 2.2k ±5%, 1/4w	4704-148049	01121	CB2225	1		
R331	E4-T5	Res, comp, 3.3k ±5%, 1/4w	4704-148056	01121	CB3325	REF		
R332	E1-T5	Res, comp, 68k ±5%, 1/4w	4704-148171	01121	CB6835	1		
R334	E2-S5	Res, comp, 22k ±5%, 1/4w	4704-148130	01121	CB2235	1		
R335	E5-T3	Res, comp, 330Ω ±5%, 1/4w	4704-147967	01121	CB3315	REF		
R336	E5-T1	Res, comp, 1.5k ±5%, 1/4w	4704-148031	01121	CB1525	REF		
R337	E5-S2	Res, comp, 27k ±5%, 1/4w	4704-148148	01121	CB2735	REF		
R338	F3-S3	Res, comp, 33k ±5%, 1/4w	4704-148155	01121	CB3335	REF		
R339	E5-S3	Res, comp, 82k ±5%, 1/4w	4704-188458	01121	CB8235	1		
R340	F3-Q3	Res, comp, 150k ±5%, 1/4w	4704-182212	01121	CB1545	1		
R341	G3-Q1	Res, comp, 8.2k ±5%, 1/4w	4704-160796	01121	CB8225	REF		
R342	G2-Q4	Res, var, ww, 1.5k ±10%, 1-1/4w	4702-156398	71450	Type 110	1		
R343	F1-P4	Res, comp, 91k ±5%, 1/4w	4704-193300	01121	CB9135	1		
R344	G4-Q1	Res, met flm, 69.8k ±1%, 1/2w	4705-162057	12400	Type CEC-TO	1		
R345	H2-P4	Res, comp, 27k ±5%, 1/4w	4704-148148	01121	CB2735	REF		
R346	G1-P2	Res, met flm, 2.49k ±1%, 1/2w	4705-193995	12400	Type CEC-TO	1		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R347	G3-N4	Res, var, ww, 1k ±20%, 1-1/4w	4702-111575	71450	Type 110	1		
R348	H1-R1	Res, comp, 5.1k ±5%, 1/4w	4704-193342	01121	CB5125	1		
R349	H1-R2	Res, comp, 390k ±5%, 1/4w	4704-193383	01121	CB3945	1		
R350	E2-R3	Res, met flm, 8.25k ±1%, 1/2w	4705-192492	12400	Type CEC-TO	1		
R351	E2-R4	Res, met flm, 28.7k ±1%, 1/2w	4705-193987	12400	Type CEC-TO	1		
R352	E3-R5	Res, met flm, 100k ±1%, 1/2w	4705-151316	12400	Type CEC-TO	1		
R353	E4-R5	Res, met flm, 422k ±1%, 1/2w	4705-198283	12400	Type CEC-TO	1		
R354	E5-Q5	Res, met flm, 909k ±1%, 1/2w	4705-159483	12400	Type CEC-TO	1		
R355	F5-R5	Res, met flm, 649Ω ±1%, 1/2w	4705-150730	12400	Type CEC-TO	1		
R356	F2-R1	Res, var, ww, 200Ω ±20%, 1-1/4w	4702-144766	71450	Type 110	1		
R357	H4-P3	Res, comp, 470Ω ±5%, 1/4w	4704-147983	01121	CB4715	REF		
R358	E4-P3	Res, comp, 7.5k ±5%, 1/4w	4704-193326	01121	CB7525	1		
R359	F4-N5	Res, met flm, 19.6k ±1%, 1/2w	4705-159640	12400	Type CEC-TO	REF		
R360	F1-N3	Res, var, ww, 6k ±5%, 1-1/4w	4702-113209	71450	Type 110	1		
R361	F5-N4	Res, met flm, 1.69k ±1%, 1/2w	4705-194001	12400	Type CEC-TO	2		
R362	H1-M5	Res, var, ww, 600Ω ±5%, 1-1/4w	4702-192179	71450	Type 110	1		
R363	F4-N1	Res, met flm, 1.69k ±1%, 1/2w	4705-194001	12400	Type CEC-TO	REF		
T301	J1-Q2	Transformer, oscillator	5602-197970	89536	5602-197970	1		
T302	I5-S5	Transformer, modulator	5602-197988	89536	5602-197988	1		
T303	I5-U1	Transformer, resonator #1	5602-197954	89533	5602-197954	1		

These resistors are factory matched. If replacement is required, an entire set, part number 4705-192849, must be ordered.

These resistors are factory matched. If replacement is required, an entire set, part number 4710-197921, must be ordered.

These resistors are factory matched. If replacement is required, an entire set, part number 4705-198168, must be ordered.

These components are factory selected. If replacement is required, replace with exact value. These parts may or may not be installed.

These components are factory matched. If replacement is required, an entire set, part number 4807-197897, must be ordered.

5-8. SERIAL NUMBER EFFECTIVITY

5-9. A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the Model 931. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List below. All parts with no code are used on all instruments with serial numbers above 123. New codes will be added as required by instrument changes.

USE CODE	EFFECTIVITY
No Code	Model 931A, 931AB, 931P, and 931PB serial number 123 and on.
A	Model 931A and 931AB serial number 123 and on.
B	Model 931P and 931PB serial number 123 and on.
C	Model 931A and 931AB serial number 123 thru 162.
D	Model 931A and 931AB serial number 163 and on.
E	Model 931P and 931PB serial number 123 thru 162.
F	Model 931P and 931PB serial number 163 and on.
G	Model 931A, 931AB, 931P, and 931PB; deleted after serial number 162.
H	Model 931A and 931AB serial number 123 thru 507.
I	Model 931A and 931AB serial number 508 and on.
J	Model 931P and 931PB serial number 123 thru 507.
K	Model 931P and 931PB serial number 508 and on.
L	Model 931A, 931AB, 931P, and 931PB; deleted after serial number ~ 507.
M	Model 931A and 931AB serial number 123 thru ~547.
N	Model 931A and 931AB serial number ~ 548 and on.
O	Model 931P and 931PB serial number 123 thru ~547.
P	Model 931P and 931PB serial number ~ 548 and on.

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON

APPENDIX A

FEDERAL SUPPLY CODE FOR MANUFACTURERS

A-1. CODE TO NAME

A-2. The following five-digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name. Suppliers not listed in the Federal Supply Code for Manufacturers have been assigned an alphabetical code by FLUKE.

00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Cleveland, Ohio
00656	Aerovox Corp. New Bedford, Massachusetts
01121	Allen-Bradley Company Milwaukee, Wisconsin
01281	Pacific Semiconductors Inc. Lawndale, California
01295	Texas Instruments, Inc. Semiconductor Components Div. Houston, Texas
01730	Circle Mfg. Co. Inc. Little Falls, New Jersey
01884	Dearborn Electronic Labs Inc. Orlando, Florida
01963	Cherry Electrical Products Corp. Highland Park, Illinois
02660	Amphenol-Borg Elect. Corp. Chicago, Illinois
02606	Fenwal Laboratories Inc. Framington, Massachusetts
02799	Arco Capacitors, Inc. Los Angeles, California
03614	Bussmann Mfg. Div. of McGraw-Edison Co. Los Angeles, California
03615	Ohmite Mfg. Co. Los Angeles, California
03877	Transitron Electronic Corp. Wakefield, Massachusetts
03911	Clairex Corp. New York, New York
03980	Muirhead Instruments, Inc. Mountainside, New Jersey
04009	Arrow Hart and Hegemen Electronic Company Hartford, Connecticut
04062	Elmenco Products Company New York, New York
04202	Winchester Electronics Co. New Milford, Connecticut
04221	Telex-Aemco Division of Telex Corp. Mankato, Minnesota
04645	Kurz-Kasch, Inc. Chicago, Illinois
04713	Motorola Inc. Semiconductor Products Division Phoenix, Arizona
05082	Tung-Sol Electric Inc. Melrose Park, Illinois
05278	Penn-East Engrg. Corp. Kutztown, Pennsylvania
05397	Union Carbide Corp. Linde Division Kemet Dept. Cleveland, Ohio
05571	Sprague Electric Company Culver City, California
05704	Alac, Inc. Glendale, California
06001	General Electric Company Capacitor Department Irmo, South Carolina
06136	Ward Leonard Electric Co. Los Angeles, California
06473	Amphenol Space and Missile Sys Chatsworth, California
06555	Beede Electrical Inst. Co. Penacook, New Hampshire
06751	Nuclear Corporation of America, Inc. U. S. Semcor Div. Phoenix, Arizona
06860	Gould National Batteries Inc. La Puente, California
07115	Corning Glass Works Electronic Components Dept. Bradford, Pennsylvania
07263	Fairchild Semiconductor Div. of Fairchild Camera and Instrument Corp. Mountain View, California
07344	Bircher Co., Inc. Rochester, New York
07792	Lerma Engineering Corp. Northampton, Massachusetts
07910	Continental Device Corp. Hawthorne, California
08530	Reliance Mica Corp. Brooklyn, New York
08863	Nylomatic Corp. Morrisville, Pennsylvania
08988	Skottie Electronics Inc. Peckville, Pennsylvania
11237	Chicago Telephone of Calif Inc. South Pasadena, California
11503	Keystone Mfg. Co. Warren, Michigan
12060	Diodes, Inc. Chatsworth, California
12136	Philadelphia Handle Co. Camden, New Jersey
12400	International Resistance Co. Control Components Division Philadelphia, Pennsylvania
12617	Hamlin Inc. Lake Mills, Wisconsin
12697	Clarostat Mfg. Co. Dover, New Hampshire
14099	Semtech Corp. Newbury Park, California
14193	California Resistor Corp. Santa Monica, California
14298	American Components Inc. Conshohocken, Pennsylvania
14752	Electro Cude Inc. South Pasadena, California
15818	Amelco Inc. Mountain View, California
15909	Daven Division Thomas A. Edison Ind. McGraw Edison Co. Livingston, New Jersey
16332	Milwaukee Relays Inc. Cedarburg, Wisconsin
16473	Cambridge Scientific Industries Inc. Cambridge, Maryland
17069	Circuit Structures Lab Santa Ana, California
17856	Siliconix Inc. Sunnyvale, California
17910	Continental Device Corp. Hawthorne, California
18083	Clevite Corp. Transistor Division Palo Alto, California
19429	Montronics, Inc. Seattle, Washington
19701	Electra Mfg. Co. Independence, Kansas
24655	General Radio Co. West Concord, Mass.
28520	Heyman Mfg. Co. Kenilworth, New Jersey
33173	General Electric Co. Tube Dept. Owensboro, Kentucky
37942	P. R. Mallory and Co., Inc. Indianapolis, Indiana
38315	Honeywell Inc. Precision Meter Division Manchester, New Hampshire
42498	National Company, Inc. Malden, Massachusetts
44655	Ohmite Mfg. Co. Skokie, Illinois
49671	Radio Corp. of America New York, New York
53021	Sangamo Electric Co. Springfield, Illinois
55026	Simpson Electric Company Chicago, Illinois
56289	Sprague Electric Co. North Adams, Mass.
58474	Superior Electric Co. Bristol, Connecticut
60399	Torrington Mfg. Co. Torrington, Connecticut
62460	USHCO Mfg. Co., Inc. Buffalo, New York
64834	West Mfg. Co. San Francisco, California
65092	Weston Instruments Div. of Daystrom, Inc. Newark, New Jersey
66150	Winslow Tele-Tronics Inc. Asbury Park, New Jersey
70563	Amperite Co. Union City, New Jersey
70903	Belden Mfg. Co. Chicago, Illinois

71400 Bussman Manufacturing
Division of McGraw Edison Co.
St. Louis, Missouri

71450 CTS Corp.
Elkhart, Indiana

71468 Cannon Electric Company
Los Angeles, California

71482 Clare, C. P. and Company
Chicago, Illinois

71590 Centralab Div. of Globe
Union, Inc.
Milwaukee, Wisconsin

71707 Coto Coil Co., Inc.
Providence, Rhode Island

71744 Chicago Miniature Lamp
Works
Chicago, Illinois

71785 Cinch Mfg. Co. and
Howard B. Jones Div.
Chicago, Illinois

72005 Driver, Wilber B., Co.
Newark, New Jersey

72092 Eitel-McCullough, Inc.
San Bruno, California

72136 Electro Motive Mfg. Co.
Willimantic, Connecticut

72354 Fast, John E. Co.
Div. of Victoreen Instr. Co.
Chicago, Illinois

72559 Essex Electronics Inc.
Berkeley Heights, New Jersey

72619 Dialight Corp.
Brooklyn, New York

72665 Mallory Battery Company
Cleveland, Ohio

72982 Erie Tech. Products Inc.
Erie, Pennsylvania

73138 Helipot Division of
Beckman Instruments Inc.
Fullerton, California

73293 Hughes Products Div. of
Hughes Aircraft Co.
Newport Beach, California

73445 Amperex Electronic Co.
Div. of North American
Philips Co., Inc.
Hicksville, New York

73559 Carling Electric Inc.
Hartford, Connecticut

73586 Circle F Mfg. Co.
Trenton, New Jersey

73899 JFD Electronics Corp.
Brooklyn, New York

73949 Guardian Electric Mfg. Co.
Chicago, Illinois

74217 Radio Switch Corp.
Marlboro, New Jersey

74306 Piezo Crystal Company
Carlisle, Pennsylvania

74542 Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970 Johnson, E. F., Co.
Waseca, Minnesota

75042 International Resistance Co.
Philadelphia, Pennsylvania

75915 Littelfuse Inc.
Des Plaines, Illinois

76854 Oak Mfg. Co.
Crystal Lake, Illinois

77342 American Machine
and Foundry Company
Potter & Brumfield Div.
Princeton, Indiana

77969 Rubbercraft Corp. of
California Ltd.
Torrance, California

78277 Sigma Instruments, Inc.
South Braintree, Mass.

79136 Waldes Kohinoor Inc.
Long Island City, New York

79497 Western Rubber Company
Goshen, Indiana

80031 Mepco Division of
Sessions Clock Co.
Morristown, New Jersey

80294 Bourns Laboratories, Inc.
Riverside, California

80583 Hammarlund Company, Inc.
New York, New York

80640 Stevens, Arnold Co., Inc.
Boston, Massachusetts

81073 Grayhill Company
La Grange, Illinois

81439 Therm-O-Disc Inc.
Mansfield, Ohio

81483 International Rectifier Corp
El Segundo, California

81590 Korry Mfg. Co.
Seattle, Washington

82376 Astron Division
Renwell Industries Inc.
East Newark, New Jersey

82389 Switchcraft Inc.
Chicago, Illinois

82872 Roanwell Corp.
Brooklyn, New York

82877 Rotron Mfg. Co., Inc.
Woodstock, New York

82879 Royal Electric Corp.
Pawtucket, Rhode Island

83003 Varo Mfg. Co., Inc.
Garland, Texas

83298 Bendix Corp.
Red Bank Division
Red Bank, Eatontown,
New Jersey

83330 Smith, Herman H., Inc.
Brooklyn, New York

83478 Rubbercraft Corp. of Am.
New Haven, Connecticut

84411 Good All Electric Mfg. Co.
Ogallala, Nebraska

86689 R.M.B. Corp.
Los Angeles, California

88419 Cornell-Dubilier Elec. Corp.
Electro-Mechanical Div.
Fuquay Springs,
North Carolina

88690 Essex Wire Corp.
R.B.M. Division
Detroit, Michigan

89536 Fluke, John, Mfg. Co., Inc.
Seattle, Washington

89730 General Electric Company
Newark Lamp Works of
Lamp Division of Consumer
Products Group
GECO
Newark, New Jersey

90205 Best Stamp and Mfg. Co.
Kansas City, Missouri

90211 Square D Company
Chicago, Illinois

90303 Mallory Battery Company
North Tarrytown, New York

91293 Johanson Mfg. Co.
Boonton, New Jersey

91407 Superior Electric Company
Oak Park, Illinois

91662 Elco Corp.
Willow Grove, Penn.

91737 Gremar Mfg. Co., Inc.
Wakefield, Massachusetts

91802 Industrial Devices, Inc.
Edgewater, New Jersey

91929 Minneapolis Honeywell
Regulator Company
Micro Switch Division
Freeport, Illinois

91934 Miller Electric Co., Inc.
Pawtucket, Rhode Island

93332 Sylvania Electric Products Inc.
Semiconductor Products Division
Woburn, Massachusetts

94145 Raytheon Company
Semiconductor Division
California Street Plant
Newton, Massachusetts

95146 Alco Electronics Mfg. Co.
Lawrence, Massachusetts

95264 Lerco Electronics Inc.
Burbank, California

95303 Radio Corp. of America
Comm. Receiving Tube &
Semiconductor Division
Cincinnati, Ohio

95354 Methode Mfg. Co.
Chicago, Illinois

95712 Dage Electric Co., Inc.
Franklin, Indiana

96733 San Fernando Electric Mfg. Co.
San Fernando, California

96881 Thomson Industries, Inc.
New Hyde Park
Long Island, New York

97945 S. S. White Dental Mfg. Co.
Plastics Division
New York, New York

97966 CBS Electronics Div. of
Columbia Broadcasting
System, Inc.
Danvers, Massachusetts

98094 Penta Laboratories, Inc.
Santa Barbara, California

98388 Accurate Sales Company
Culver City, California

98743 James Vibrapower Corp.
Chicago, Illinois

98925 Semiconductor Division
of Clevite Corp.
Waltham, Massachusetts

99120 Plastic Capacitors, Inc.
Chicago, Illinois

99217 Southern Electronics Corp.
Burbank, California

99515 Marshall Industries
Electron Prod. Div.
Pasadena, California

Revised May 15, 1966
Using H4-2 Dated March 1963

Sales and Service Representatives

ALABAMA

HUNTSVILLE
BCS Associates, Inc.
2317 Bob Wallace Ave. S.W.
Tel. (205) 534-1648

ALASKA

SEATTLE
Instrument Specialists, Inc.
5950 Sixth Ave. South
Suite 106
Seattle, Washington
Tel. (206) 767-4260

ARIZONA

PHOENIX
Barnhill Associates
4900 E. Indian School Road
Tel. (602) 959-2115

CALIFORNIA

LOS ANGELES
Instrument Specialists, Inc.
2870 Los Feliz Place
Tel. (213) 665-5181

SAN FRANCISCO
Instrument Specialists, Inc.
2359 De La Cruz
Santa Clara, California
Tel. (408) 244-1505

COLORADO

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1170 S. Sheridan Blvd.
Tel (303) 934-5505

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Glastonbury, Connecticut
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940 N. Fern Creek Ave.
Tel. (305) 425-2764

HAWAII

HONOLULU
Industrial Electronics, Inc.
646 Queen Street
Tel. (808) 506-095

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Cozzens & Cudahy, Inc.
9501 W. Devon Ave.
Rosemont, Illinois
Tel. (312) 825-1144

INDIANA

INDIANAPOLIS
Cozzens & Cudahy, Inc.
44 Kirk Drive
Tel. (317) 244-2456

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NEW ORLEANS
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Metairie, Louisiana
Tel. (504) 888-2266

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11501 Huff Court
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1046 Massachusetts Avenue
Arlington, Massachusetts
Tel. (617) 646-1034

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13657 Grand River Ave.
Tel. (313) 838-7324

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7710 Computer Ave.
Tel. (612) 920-1022

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10534 Natural Bridge Road
Edmundson, Missouri
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Pleasantville, New York
Tel. (914) 769-1811

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528 Old Country Road
Plainview, Long Island
Tel. (516) 433-1421

ROCHESTER
SBM Associates, Inc.
800 Linden Avenue
Tel. (716) 381-8330

SYRACUSE
SBM Associates, Inc.
138 Pickard Bldg.
5858 E. Molloy Road
Tel. (315) 454-9377

NORTH CAROLINA

GREENSBORO
BCS Associates, Inc.
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Tel. (919) 273-1918

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23203 Lorain Road
North Olmsted, Ohio
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Suite 106
Seattle, Washington
Tel. (206) 767-4260

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Acromatix Associates, Inc.
3118 Germantown Pike
Fairview Village, Pennsylvania
Tel. (215) 279-0377

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Technitron, Inc.
114 Spring Grove Road
Tel. (412) 371-1231

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Richardson, Texas
Tel. (214) AD 1-2573

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Barnhill Associates
Suite 203
3810 Westheimer
Tel. (713) NA 1-0040

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5950 Sixth Ave. South
Suite 106
Seattle, Washington
Tel. (206) 767-4260

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11501 Huff Court
Kensington, Maryland
Tel. (301) 946-0300

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Allan Crawford Associates, Ltd.
5901 East Broadway
North Burnaby 2, B.C.
Tel. (604) 291-7161

ONTARIO

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376 Churchill Avenue — Suite 106
Tel. (613) 725-1288

TORONTO
Allan Crawford Associates, Ltd.
65 Martin Ross Avenue
Downsview, Ontario
Tel. (416) 636-4910

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MONTREAL
Allan Crawford Associates, Ltd.
6999 Cote de Neiges Road
Tel. (514) 739-6776

International Representatives

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Elmesco Instruments
41 Carter Road
Brookvale, N.S.W., Australia

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Techn. Beratung
Mollardgasse 54
Vienna VI, Austria

BELGIUM

C. N. Rood S/A
30 Rue Leon Frederic
Brussels 4, Belgium

DENMARK

Tage Olsen A/S
Ronnegade 1-0
Copenhagen, Denmark

FINLAND

Oy Findip AB Ltd.
Mannerheimintie 29C
Helsinki 25, Finland

FRANCE

S. E. R. I. E. L., s. a.
48 Avenue Victor Hugo
Clamart (Seine) France

HONG KONG and MACAO

Intronics Ltd.
4 Hankow Road, Suite 4A
Kowloon, Hong Kong

ISRAEL

R. D. T. Electronics
Engineering Ltd.
P.O. Box 21082
13 Dov-Hos Street
Tel-Aviv, Israel

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7 Pizza DeAngli
20146 Milano, Italy

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Tokyo, Japan

Toyo Trading Co., Ltd.
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Higashika, Osaka, Japan

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M. - C International
Room 516, Bando Building
Seoul, Korea

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C. N. Rood N. V.
Post Office Box 4542
Rijswijk (Z. H.) The Netherlands

Fluke Nederland N. V.
Post Office Box 5053
Tilburg, The Netherlands

NEW ZEALAND

Sample Electronics (N. Z.) Ltd.
8 Matipo Street
Onehunga
Auckland, New Zealand

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Morgenstierne & Co. A/S
Wesselsgt. 6
Oslo, Norway

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Johannesburg, So. Africa

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P.O. Box 3641
Cape Town, So. Africa

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Madrid, Spain

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Tradgardsgatan 7
Motala, Sweden

SWITZERLAND

Omni Ray AG
Dufourstrasse 56
8008 Zurich, Switzerland

TAIWAN

Heighten Scientific Co., Ltd.
P.O. 1408
Taipei, Taiwan

THAILAND

G. Simon Radio Ltd.
30 Patpong Avenue
Suriwong
Bangkok, Thailand

THE UNITED KINGDOM

Fluke International Corp.
P.O. Box 102
Watford-Herts, England

WEST GERMANY

Rohde & Schwarz Vertriebs - Gmbh
5000 Koeln
Hohe Strasse 160-168
West Germany

Rohde & Schwarz Handels - Gmbh
1000 Berlin 10
Ernst - Reuter - Platz 10
West Germany

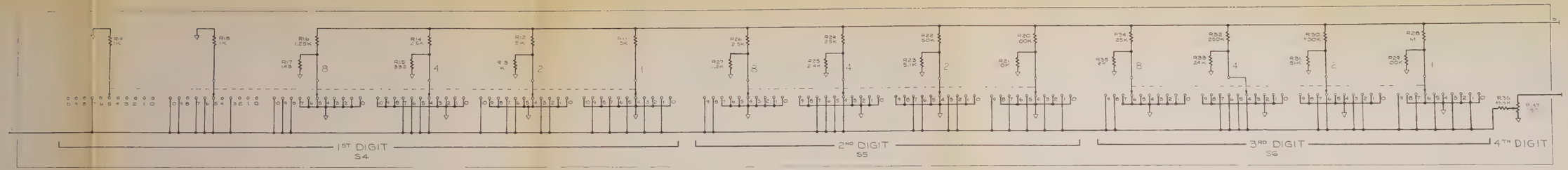
Rohde & Schwarz Vertriebs - Gmbh
2000 Hamburg 50
Grosse Bergstrasse 213-217
West Germany

Rohde & Schwarz Vertriebs - Gmbh
7500 Karlsruhe
Kriegsstrasse 39
West Germany

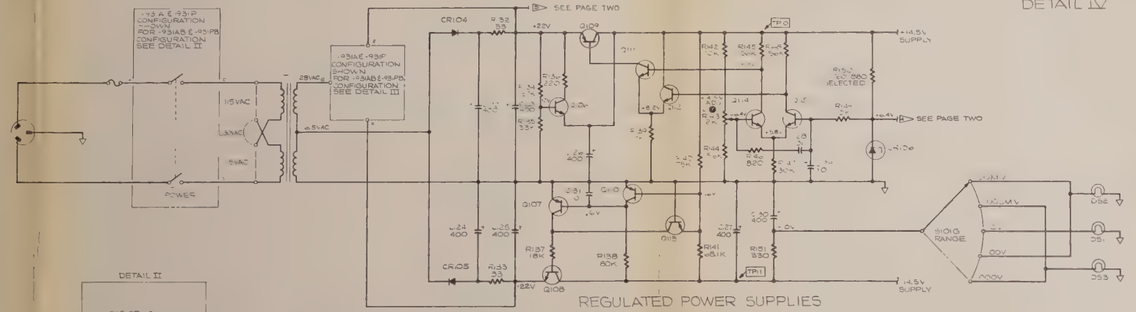
Rohde & Schwarz Vertriebs - Gmbh
8000 Muenchen
Dachauer Strasse 109
West Germany

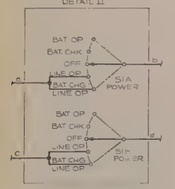
In Europe contact FLUKE NEDERLAND, N. V., Post Office Box 5053, Tilburg, The Netherlands

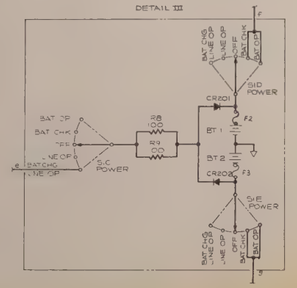
FLUKE



DETAIL IV







NOTES:

1. UNLESS OTHERWISE NOTED, RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS
2. ● INDICATES INTERNAL ADJUSTMENT (LETTER IDENTIFICATION)
3. TP2 IDENTIFIES TEST POINT (NUMBER IDENTIFICATION)
4. ALL FLAGNOTES WITH LIKE NUMBERS ARE CONNECTED
5. VOLTAGES NOTED ARE APPROXIMATE VALUES FOR TROUBLE SHOOTING ONLY, NOT FOR CALIBRATION. MODE SWITCH IN TVM POSITION, NO A.C. SIGNAL IN, 115VAC POWER
6. * FACTORY SELECTED COMPONENTS, MAY BE OMITTED

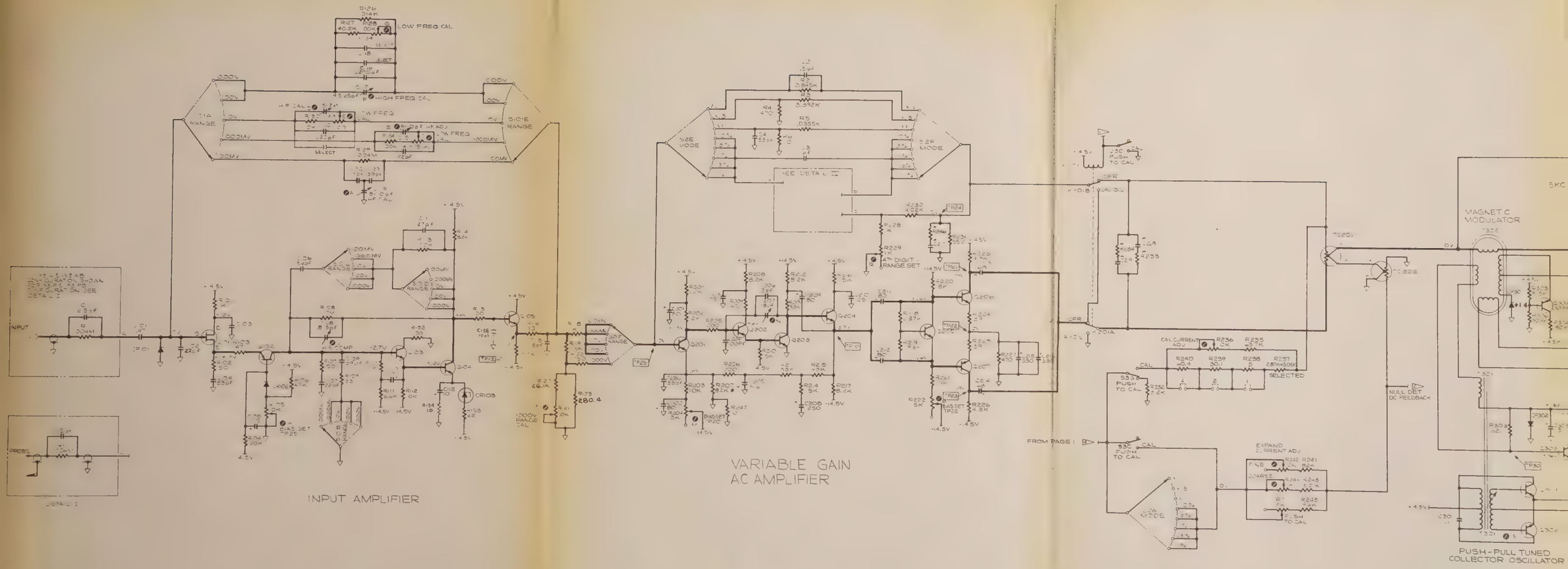
REFERENCE DESIGNATIONS

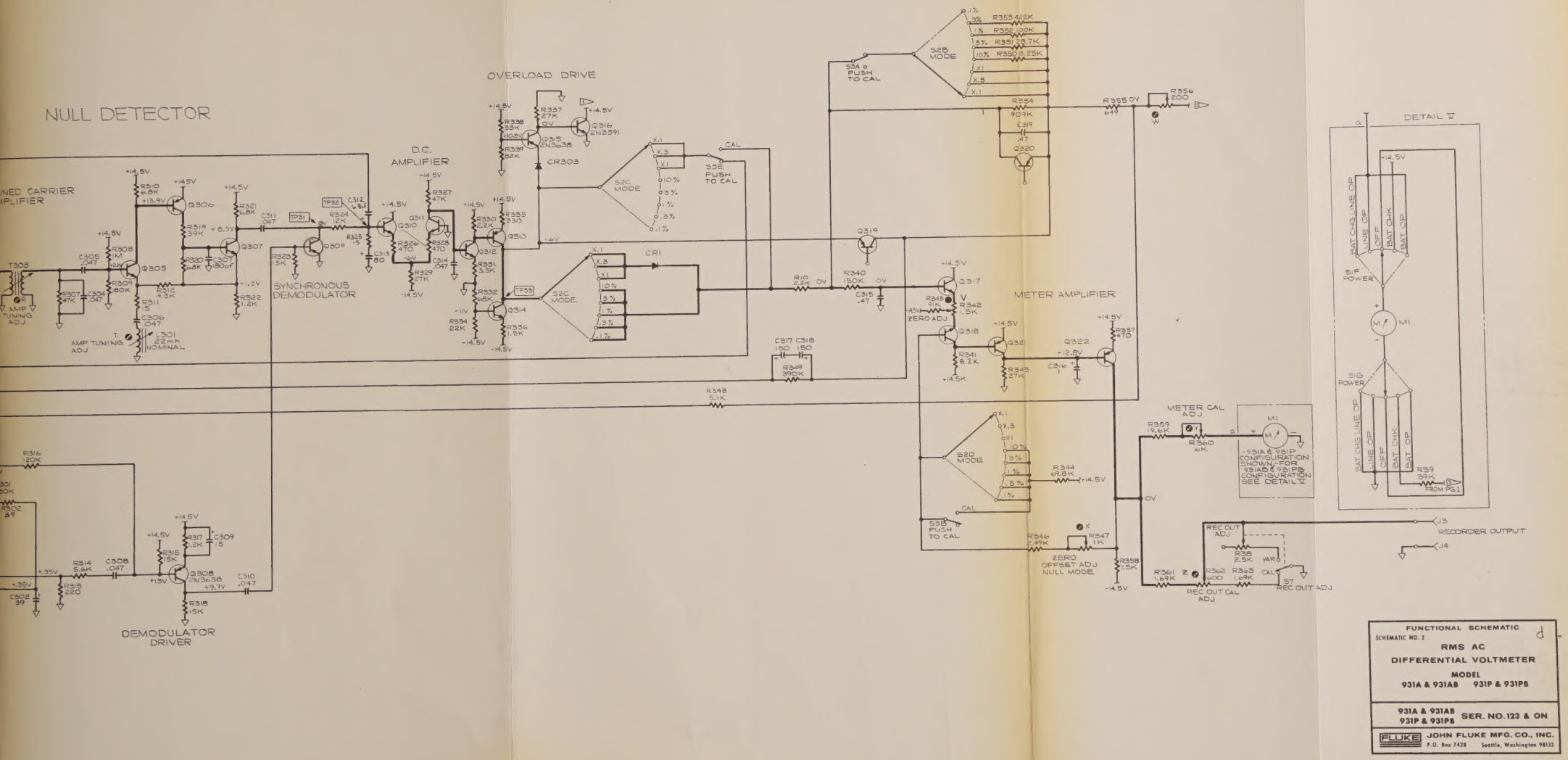
CHASSIS ASSY:
C1-4, CR1, M1, R1-39, S1-7, T1
401 BOARD
C101-136, CR101-106, Q101-115, R101-153, S101
402 BOARD
C201-220 CR201-202, K201, Q201-207, R201-247, TC201-202
403 BOARD
C301-319, CR301-308, L301, Q301-322, R301-322, S34-363, T301-302

FUNCTIONAL SCHEMATIC
SCHEMATIC NO 1
RMS AC
DIFFERENTIAL VOLTMETER
MODEL
931A & 931AB 931P & 931PB

931A & 931AB
931P & 931PB SER. NO. 123 & ON

FLUKE JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133


INPUT AMPLIFIER
VARIABLE GAIN
AC AMPLIFIER
PUSH-PULL TUNED
COLLECTOR OSCILLATOR
MAGNET C
MODULATOR
LOW FREQ CAL
HIGH FREQ CAL
HF CAL
LF CAL
LF FREQ
HF FREQ
HF ADJ
1A RANGE
SLOPE RANGE
SELECT
BIAS SET
HF COMP
INPUT
PROBE
DETAIL 1
SEE DETAIL
5E MODE
5F MODE
DIGIT RANGE SET
5D PUSH TO CAL
5E PUSH TO CAL
5F PUSH TO CAL
CAL CURRENT ADJ
EXPAND CURRENT ADJ
NULL DET DC FEEDBACK
FROM PAGE 1
1A MODE
COARSE
FINE
5KC



FUNCTIONAL SCHEMATIC
SCHEMATIC NO. 2

RMS AC DIFFERENTIAL VOLTMETER

MODEL
931A & 931AB 931P & 931PB

931A & 931AB
931P & 931PB
SER. NO. 123 & ON

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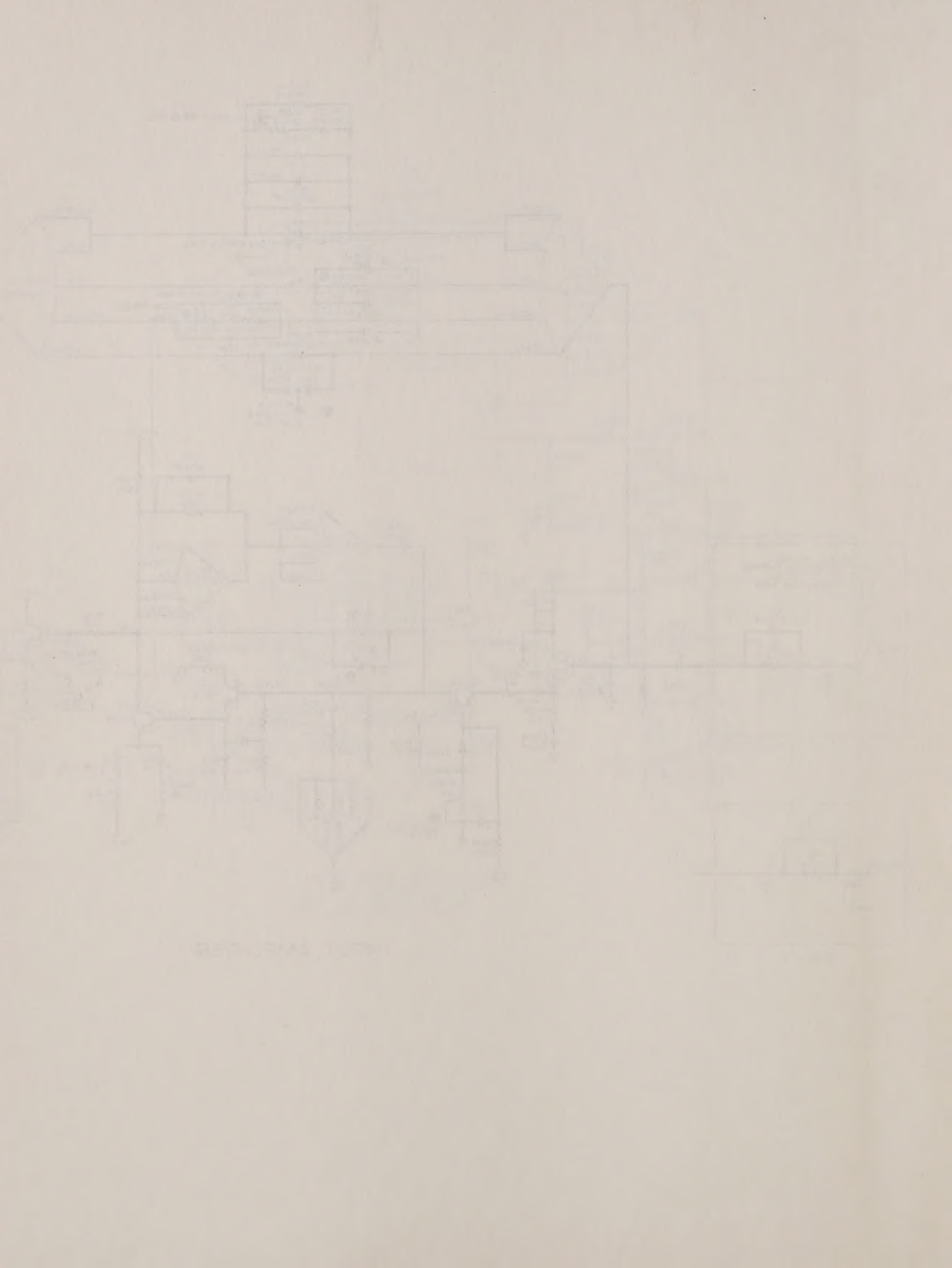
P.O. Box 7428 Seattle, Washington 98133



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